

# University of Rajasthan Jaipur

## SYLLABUS

### M.Sc. (ZOOLOGY)

#### (Semester Scheme)

I & II Semester Examination 2023-24

III & IV Semester Examination 2024-25

*[Signature]*  
Dy. Registrar  
(Academic)  
University of Rajasthan  
JAIPUR *[Signature]*

**MAX. MARKS: 100**

**PASS MARKS: 36**

**THEORY PAPER DURATION: 3 HRS.**

**PRACTICAL: 6 HRS**

### **SCHEME OF EXAMINATION ZOOLOGY**

- As per discussion of academic council, the student will require to earn 120 credits for PG course out of total 144 credits.
- In theory, 15 hrs of teaching is equal to one credit.
- In practicals, 45 hrs of laboratory works is equal to 2 credits.
- Each Semester of PG course shall have 36 credits.
- Each Semester will have continuous assessment which will include internal assessment in theory and practical by internal examination /seminar/oral examination- Viva voce etc. and the maximum marks will be 30.
- Each theory paper shall carry 100 marks. It will be of 3 (three) hrs duration.
- Part A of question paper shall contain 10 ( Ten) very short answer type questions covering the entire syllabus. Each question will carry 2 (two) marks i.e. part A will be of total 20 marks.
- In part B, there will be 4 questions, one per unit with internal choice. Each question will carry 20 marks i.e. total of 80 marks.
- Each practical examination will be of 6 hrs duration and will involve laboratory experiments / exercises and Viva -voce examination.

### **SCHEME OF PRACTICAL EXAMINATION**

#### **NOTE:**

**For first, second, third and fourth Semesters, the scheme of practical examination is given after the practicals.**

PJ / Jm

**First Semester (With Laboratory Work)**

S. No.	Subject Code	Course Title	Course Category	Credit
1.	ZOL C101	Biosystematics & Taxonomy	CCC	4
2.	ZOL C102	Biology of Invertebrates	CCC	4
3.	ZOL C103	Biochemistry	CCC	4
4.	ZOL 111	Lab (Based on ZOL C101, ZOL C102 and ZOL C103)	CCC	6
5.	ZOL E101	Fundamentals of Computers and Bioinformatics	ECC	4
6.	ZOL E102	Genetics	ECC	4
7.	ZOL E103	Applied Zoology	ECC	4
8.	ZOL E104	Toxicology	ECC	4
9.	ZOL E105	Biosafety & Bioethics	ECC	4
10.	ZOL E106	Parasitology	ECC	4
11.	ZOL 112	Elective Lab (Based on ZOL E101/ ZOL E102/ ZOL E103/ ZOL E104/ ZOL E105/ ZOL E106)	ECC	6

**Second Semester (With Laboratory Work)**

S. No.	Subject Code	Course Title	Course Category	Credit
1.	ZOL C201	Physiology	CCC	4
2.	ZOL C202	Molecular Biology	CCC	4
3.	ZOL C203	Biostatistics	CCC	4
4.	ZOL 211	Lab (Based on ZOL C201, ZOL C202 and ZOL C203)	CCC	6
5.	ZOL E201	Immunology	ECC	4
6.	ZOL E202	Wildlife: Its Management & Conservation	ECC	4
7.	ZOL E203	Applied Biology	ECC	4
8.	ZOL E204	Histology and Histopathology	ECC	4
9.	ZOL E205	Population Genetics	ECC	4
10.	ZOL 212	Elective Lab (Based on ZOL E201/ZOL E202/ZOL E203/ZOL E204/ ZOL E205)	ECC	6

**Third Semester (With Laboratory Work)**

S. No.	Subject Code	Course Title	Course Category	Credit
1.	ZOL C301	Biology of Chordates	CCC	4
2.	ZOL C302	Gene and Differentiation	CCC	4
3.	ZOL C303	Evolution	CCC	4
4.	ZOL 311	Lab (Based on ZOL C301, ZOL C302 and ZOL C303)	CCC	6
5.	ZOL 3A01 ZOL 3B01 ZOL 3C01	Cancer and Radiation Biology Cell and Molecular Biology Entomology	ECC	4

3  
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	ZOL 3D01 ZOL 3E01	Environmental Biology Reproductive Biology		
6.	ZOL 3A02 ZOL 3B02 ZOL 3C02 ZOL 3D02 ZOL 3E02	Cancer and Radiation Biology Cell and Molecular Biology Entomology Environmental Biology Reproductive Biology	ECC	4
7.	ZOL 3A03 ZOL 3B03 ZOL 3C03 ZOL 3D03 ZOL 3E03	Cancer and Radiation Biology Cell and Molecular Biology Entomology Environmental Biology Reproductive Biology	ECC	4
8.	ZOL 312A ZOL 312B ZOL 312C ZOL 312D ZOL 312E	Elective Lab Based on: ZOL 3A01, ZOL 3A02 and ZOL 3A03 ZOL 3B01, ZOL 3B02 and ZOL 3B03 ZOL 3C01, ZOL 3C02 and ZOL 3C03 ZOL 3D01, ZOL 3D02 and ZOL 3D03 ZOL 3E01, ZOL 3E02 and ZOL 3E03	ECC	6

#### Fourth Semester (With Laboratory Work)

S. No.	Subject Code	Course Title	Course Category	Credit
1.	ZOL 401	Ecology	CCC	4
2.	ZOL 402	Ethology	CCC	4
3.	ZOL 403	Tools & Techniques	CCC	4
4.	ZOL 411	Lab (Based on ZOL 401, ZOL 402 and ZOL 403)	CCC	6
5.	ZOL 4A01 ZOL 4B01 ZOL 4C01 ZOL 4D01 ZOL 4E01	Cancer and Radiation Biology Cell and Molecular Biology Entomology Environmental Biology Reproductive Biology	ECC	4
6.	ZOL 4A02 ZOL 4B02 ZOL 4C02 ZOL 4D02 ZOL 4E02	Cancer and Radiation Biology Cell and Molecular Biology Entomology Environmental Biology Reproductive Biology	ECC	4
7.	ZOL 4A03 ZOL 4B03 ZOL 4C03 ZOL 4D03 ZOL 4E03	Cancer and Radiation Biology Cell and Molecular Biology Entomology Environmental Biology Reproductive Biology	ECC	4
8.	ZOL 412A ZOL 412B ZOL 412C ZOL 412D ZOL 412E	Elective Lab Based on: ZOL 4A01, ZOL 4A02 and ZOL 4A03 ZOL 4B01, ZOL 4B02 and ZOL 4B03 ZOL 4C01, ZOL 4C02 and ZOL 4C03 ZOL 4D01, ZOL 4D02 and ZOL 4D03 ZOL 4E01, ZOL 4E02 and ZOL 4E03	ECC	6

Note- Elective practical/s will be based on the elective theory paper/s opted.

**M. Sc. ZOOLOGY I SEMESTER (2023-2024)**  
**CORE PAPER**  
**ZOL C101: BIOSYSTEMATICS AND TAXONOMY**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

1. Taxonomy: Definition and basic concept of biosystematics and taxonomy.
2. History, scope and application of biosystematics.
3. Taxonomic diversity: Definition and types of various taxonomic categories, micro- and macro- taxonomy.
4. Dimensions of speciation: Species category, sub-species and other intra-species categories.
5. Kingdom of life: General outline of kingdom including Monera and Protista; Broad outline and diversity in kingdom Animalia.

**UNIT-II**

**Modern trends in taxonomy**

1. Behavioural taxonomy
2. Chemotaxonomy
3. Cytotaxonomy
4. Molecular taxonomy
5. Neo-taxonomy
6. Numerical taxonomy.

**UNIT-III**

1. Taxonomic procedures: Collection, preservation, curation and process of identification.
2. Taxonomic character of different kinds-quantitative and qualitative analysis of variation.
3. Theories of biological classification: Hierarchy of categories.
4. Interpretation and application of important rules and formation of scientific names of different taxa.

**UNIT-IV**

1. Interpretation and application of important rules of zoological nomenclature, formation of scientific names of the various taxa.
2. Taxonomic keys: Their merits and demerits.
3. International code of zoological nomenclature (ICZN).
4. Systematic publications and different kinds of publications.

**PRACTICALS**

1. Identification, classification and study of the animals from major invertebrate groups (Protozoa to Hemichordata including minor phyla) using museum specimens, microscopic slides, models or charts or photographs.
2. Preservation techniques of selected invertebrates.
3. Museum specimens and slides:

- PROTOZOA: *Gregarina, Monocystis, Ceratium, Euplotes, Noctiluca, Radiolarian, Stentor, Opalina*
- PORIFERA: Museum specimen of *Hyalonema* and *Euspongea*, Sectional view of *Sycon* (T. S. & L. S.), *Grantia* (T. S.)
- COELENTERATA (CNIDARIA): Slides of *Obelia* polyp and medusa, *Pennaria, Aurelia*-tentaculocytes. Museum specimens of *Virgularia, Spongodes, Zoanthus, Favia*.
- HELMINTHES: Slides of *Temnocephala*.  
Museum Specimens of *Ascaris lumbricoides, Taenia solium, Planaria*.
- ANNELIDA: Slides of *Ozobranchus, Glossiphonia*.  
Museum specimens of *Eunice, Polynoe, Terebella, Eurythoe*.
- ARTHROPODA: Slides of *Cyclops, Daphnia, Chelicerata*, Section of *Peripatus*.  
Museum specimen of *Balanus, Lepas, Palinurus, Uca princeps, Pycna, Emerita, Gongylus, Belostoma, Limulus, Squilla, Eupagurus*.
- MOLLUSCA: Museum specimens of *Dolabella, Pteria, Nerita, Sanguinolaria, Chicoreus, Ficus, Lambis, Tridacna, Onchidium, Oliva, Murex, Turritella, Bulla, Cardium*.
- ECHINODERMATA: Museum Specimens of *Linckia, Echinodiscus, Holothuria, Antedon*.
- MINOR PHYLA: Slides of *Bugula, Plumatalla, Cristatella, Pectinella*.  
Museum Specimen of *Phoronis, Dendrostoma*.
- LARVAE: Planula, Redia, Cercaria, Metacercaria, Trochophore, Nauplius, Zoea, Mysis, Phyllosoma, Trilobite larvae of *Limulus*, Antilon, Veliger, Bipinnaria, Ophiopluteus and Echinopluteus, Auricularia, Tornaria.

**Note : Photographs may be supplemented if unavailable.**

**Visit to a river/pond/sea: Collection, preservation, curation and identification of animals.**

#### **SUGGESTED BOOKS**

1. Biodiversity, E. O. Wilson, Academic Press; Washington.
2. Principles of Animal Taxonomy; G. G. Simpson. Oxford IBH Publishing Company.
3. Elements of Taxonomy. E. Mayer.
4. The diversity of life (The College Edition), E. O. Wilson. W. W. Norton & Co.
5. Theory and Practice of Animal Taxonomy. V. C. Kapoor. Oxford IBH Publishing Co. Pvt. LTD.
6. Advancement in Invertebrates Taxonomy and Biodiversity. Rajeev Gupta. Agrobios International.
7. The Invertebrates, Hyman, L. H. Vol. 1 to 9. McGraw Hill Co., New York.
8. A Biology of Higher Invertebrates, W. D. Russell-Hunter, The Macmillan Co. Ltd., London.

9. Collection, preservation and identification of animals. J. R. B. Alfred and Ramakrishna (2004). Zoological survey of India Publications.
10. The Biology of Biodiversity, M. Kato, Springer.

**M. Sc. ZOOLOGY I SEMESTER  
CORE PAPER  
ZOL C102: BIOLOGY OF INVERTEBRATES**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

1. Origin of Protozoa, parazoa and metazoa.
2. Origin of radiata and bilateria.
3. Origin, characters and types of metamerism.
4. Origin and evolution of coelom.
5. Evolution of reproductive and non-reproductive units (evolution of sex) division of labour and social evolution.

**UNIT-II**

1. Locomotory organs and mechanisms of locomotion in invertebrates, flight mechanism of Insects, modification of foot organelles in Mollusca.
2. Feeding and digestion in invertebrates.
3. Excretory and osmo-regulatory organs and their mechanisms in invertebrates

**UNIT-III**

1. Respiration in invertebrates.
2. Nervous system in invertebrates: (i) Primitive nervous system- Coelenterata and Echinodermata and (ii) Advanced nervous system- Annelida, Crustacea, Insecta and Mollusca.
3. Reproduction in invertebrates.

**UNIT-IV**

1. Introduction to minor phyla, their salient features and characters
2. Origin and significance of mesozoa, ctenophora and rhynchocoela.
3. Larval forms and their significance, free living, marine & freshwater protostome and deuterostome larval forms (including trochophore), crustacean, mollusc and insect larval forms, their strategies and significance, parasitic larva, larvae of parasitic forms.

**PRACTICALS**

- I. **Anatomy**
  1. Leech : Alimentary canal, nephridial and reproductive system
  2. Crab: Nervous system.
  3. Cockroach: Nervous system and reproductive system.

4. Aplysia, Sepia and Unio- Nervous system.
5. Sea Urchin – Aristotle's lantern.
6. Holothuria – General anatomy, alimentary canal.

## II. Collection, culture, live study & permanent mounting

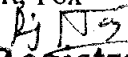

1. *Amoeba, Paramecium.*
2. *Hydra.*
3. Trematodes, Cestodes and Nematodes.
4. Permanent Mounting - *Obelia, Sertulria, Companularia, Cercaria, Daphnia, Cyclops, Zoa, Megalopa, Mysis, Lucifer*
5. Mouth parts and salivary glands of cockroach, nephridia of leech.

### Note:

- **Anatomy:** Study of systems of the prescribed types with the help of dissection.
- With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
- It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently

### SUGGESTED BOOKS

1. Invertebrate Zoology: A Functional Evolutionary Approach, Edward E. Ruppert, Richard S. Fox
2. Invertebrate Zoology, R. S. K. Barnes.
3. The Invertebrates. Vol.1. Protozoa through Ctenophora, Hyman, L.H. McGraw Hill Co., New York.
4. The Invertebrates. Vol.2. Hyman, L.H. McGraw Hill Co., New York.
5. The Invertebrates. Smaller Coelomate Groups, Vol. 5. Hyman, L.H. McGraw Hill Co., New York.
6. The Invertebrates. Vol.8. Hyman, L.H. McGraw Hill Co., New York and London
7. Invertebrate Structure and Function. Barrington, E.J.W. Thomas Nelson and Sons Ltd., London.
8. Invertebrates, Richard C. Brusca, Gary J. Brusca and Nancy J. Haver.
9. A Biology of Higher Invertebrates, Russel-Hunter, W.D. McMillan Co. Ltd., London.
10. Student Text Book of Zoology. Vol. I, II and III. Sedgwick A. Central Book Depot, Allahabad.
11. Text book of Zoology. Parker, T.J., Haswell. W.A. Macmillan Co., London.
12. Biology of the Invertebrates by Jan A. Pechenik.
13. Invertebrate Zoology Laboratory Manual, Robert L. Wallace, Walter K. Taylor
14. The Invertebrates: A Synthesis - R. S. K. Barnes Peter P. Calow P. J. W. Olive D. W. Golding J. I. Spicer.
15. Reproductive Behavior and Evolution (Evolution, Development and Organization of Behavior) Rosenblatt, J, Springer, 1997.
16. Invertebrate Zoology: A Functional Evolutionary Approach, 7<sup>th</sup> Edition, Ruppert, Fox & Barness, Cengage India, 2015.

  
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**M. Sc. ZOOLOGY I SEMESTER  
CORE PAPER  
ZOL C103: BIOCHEMISTRY**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Scope of biochemistry:** Biomolecules, Chemical bonds, pH, Acid, base, buffer, Concept of free energy.

**Proteins**

1. Covalent properties of proteins: Structure and chemistry of amino acid, isolation and purification of protein, protein sequencing, covalent modifications, protein splicing.
2. Secondary and tertiary structures of proteins, peptides and peptide bonds, Ramchandaran plots and amino acid propensities, common secondary structures, protein tertiary structure and folding patterns, common tertiary structural motifs, role of packing constraints in tertiary structure patterns.
3. Globular and fibrous protein, water and hydrophobic effect, tertiary and quaternary effect, motifs in globular proteins, fibrous proteins (keratin, fibrin, collagen and elastin).
4. Protein folding and thermodynamics, Levinthal paradox, \*condensation and molten globules, chaperone assisted protein folding.
5. Amino acid sequences variation and protein misfolding diseases, allostery (Hemoglobin), myoglobin structure and oxygen binding.
6. Hemoglobin subunits cooperatively, Hill coefficient, Quaternary structural change , sickle cell and other molecular diseases

**UNIT-II**

**Carbohydrates: Structure and biological importance**

1. Monosaccharides
2. Oligosaccharides
3. Polysaccharides (Storage and structural polysaccharides, glycosaminoglycans)
4. Glycoconjugates (glycoprotein and proteoglycans).

**Lipids**

1. Fatty acids: Structure, nomenclature, acyl glycerols, wax, phospholipids, sphinogolipids, glycolipids, lipoproteins.
2. Terpenoids and sterols: Structure, properties and functions.
3. Functions of lipids.

**UNIT-III**

**Vitamins**

1. Classification, structure, occurrence and functions and fat soluble vitamins
2. Classification, structure, occurrence and biological function deficiency symptoms of water soluble vitamins.

**Enzymes**

1. Enzyme as biocatalyst, the kinetics of enzyme catalysis, principles of enzyme catalysis, proteases, polymerases and other examples.
2. Co-enzymes and Co-factors, Isozymes.
3. Enzyme inhibition, allosteric enzyme.
4. RNA catalysis, chemistry and structure of ribozymes, evolutionary implications, enzymes as biosensor.

#### UNIT-IV

##### Metabolism

1. Catabolism, anabolism, metabolic pathway, regulation, concept of free energy
2. Carbohydrate metabolism: Enzymatic reactions, regulation importance of Glycolysis, Citric acid cycle, Pentose phosphate pathway, glycogenolysis, glycogenesis
3. Lipid metabolism: Fatty acid oxidation and biosynthesis, Beta-oxidation.
4. Amino acid metabolism: Catabolism of amino acid, transamination, deamination, biosynthesis of non essential amino acids, fate of carbon skeleton
5. Nucleotide metabolism: Degradation of purine and pyrimidine nucleotides; biosynthesis (*de novo*, salvage pathways) of purine and pyrimidine nucleotides.
6. Oxidative phosphorylation and mechanism of ATP biosynthesis.

##### Metabolic disorders

1. Carbohydrate – Galactosemia, Glycogen storage disease (Von Gierke disease), Hereditary fructose intolerance and Diabetes mellitus.
2. Protein – Phenyl ketonurca, Maple syrup urine disease, Carbamoyl phosphate synthetase I deficiency, alkaptonurea.
3. Lipid- Lipid storage disorder (Gaucher's disease, gangliosidoses), Diabetic ketoacidosis, Coenzyme A dehydrogenase deficiencies, Carnitine related deficiencies.
4. Nucleotide- Lesh-nyhan syndrome, Gout immunodeficiency diseases associated with defects in purine degradation.

##### PRACTICALS

1. Verification of Beer Lambert's Law using any colour solution
2. Determination of absorption maxima of a coloured solution
3. Standard curve –cholesterol, protein
4. Determination of pH of different solutions.
5. Quantities estimation of the following in various tissues.
  - Carbohydrates: Glycogen, & Glucose
  - Proteins: Total protein.
  - Lipids: Total Lipid & Cholesterol
  - Nucleic Acid: DNA and RNA
  - Enzymes; Acid and Alkaline Phosphatase
6. Paper chromatography: Unidimensional chromatography using amino acids from purified samples and biological materials.( Ascending & Descending )
7. Determination of serum protein through paper / PAGE electrophoresis.

##### Note:

1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

##### SUGGESTED BOOKS

Dr. K. S. Chandra  
 Professor  
 University of Madras  
 1997

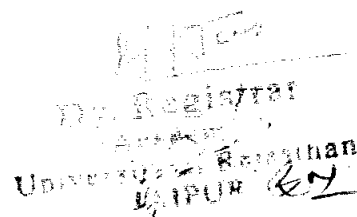
1. Biochemistry, Albert's R.H. Frey, P.A. and Jencks, W.P. Jones, and Bartlett Publisher, Boston/London 1992.
2. Lehninger Principles of Biochemistry, Nelson D.L. And Cox, M.M. acmillan/Worth Publishers 2000.
3. Biochemistry, Stryker L. W.H. Freeman and Co. New York 2001
4. Fundamentals of Biochemistry, Voet D., Voet J.G. and Pratt C.W. Johan Wiley and Sons Inc. New York, 1999.
5. Principles and Techniques of Practical Biochemistry, Wilson K. and Walker , J. Cambridge University Press Cambridge, 1994.
6. Principles of Biochemistry, Zubay G.L. Parson W. W. and Vence. D.E. Wm. C Brown Publishers, Oxford, England 1995.
7. Harper's Biochemistry, Murray, Granner, May Rodwell, McGraw Hill Publication, 2000.
8. Biochemistry, Donald Voet, Judith G. Voet.
9. Biochemistry, Mathew, C.K. Van Holde, K.E. Ahren, K.G. Peason Education Pvt. Ltd, Delhi, India 2003
10. Principles of Biochemistry, Horton, H.R. Morsanl. A Scringeour, K.G., Perry, M.D. Rawn, J.D. Peasons Educations, International, 2006.
11. Biochemistry (The Molecular Basis of Life, Mckee, T. Mc Kee, J.R. Mc Grew Hill Companying.
12. Biochemistry and Molecular Biology, Elliort, W.H. Elliott, D.C. Oxford University Press, Oxford, 2003.
13. Lippincott'S Illustrated Review by Champe, P.C. Harvey, R.A. Lippincott Williams & Wilkins, Philadelphia.

### ZOL 111: PRACTICAL-I

(BASED ON ZOL C-101, ZOL C-102 and ZOL C-103)

#### Scheme for Practical Examination

	<b>Max. Marks: 100</b>	<b>Time: 6 hrs</b>
1.	Exercise (Core 1)	16
2.	Exercise (Core 2)	16
3.	Exercise (Core 3)	16
4.	Spotting (8 × 3)	24
5.	Seminar	09
6.	Viva Voce	10
7.	Record	09


  
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**M. Sc. ZOOLOGY I SEMESTER**  
**ELECTIVE**  
**ZOL E101: FUNDAMENTAL OF COMPUTERS AND BIOINFORMATICS**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Fundamentals of computers**

1. Types of computers
2. Basic components of a computer
3. Generations of computer
4. Number system: Interconversion between binary, octal, decimal and hexadecimal
5. Softwares: System & application softwares
6. Operating systems: MS DOS, MS Windows, Unix/Linux
7. MS Office: MS Word, MS Excel, Power Point
8. Elementary idea of Adobe Photoshop
9. Internet: Physical and logical topologies, types of networking (LAN, MAN and WAN)
10. Web search engines: Yahoo, Google, MSN and Entrez (including Pubmed).

**UNIT-II**

**Introduction of bioinformatics**

1. History, definitions & scope of bioinformatics
2. Related fields and areas of bioinformatics
3. Applications of bioinformatics
4. Bioinformatics in India.

**Biological database**

1. Classification: Primary, secondary and composite databases
2. Nucleotide sequence databases: GenBank, EMBL and DDBJ
3. Protein sequence databases: SWISS-PROT, TrEMBL, UniPROT and PROSITE
4. Structural databases: Protein Data Bank (PDB), Molecular Modeling Database (MMDB), Nucleic Acid Database (NDB), Structural Classification of Proteins (SCOP) and Class Architecture Topology Homology (CATH).

**UNIT-III**

**Sequence analysis**

1. Types of sequence alignment: According to sequence number and sequence length, homologous sequences
2. Methods of sequence alignment: DOT PLOT or DOT MATRIX, Dynamic programming, Heuristic methods (FASTA and BLAST)
3. Scoring scheme: Point accepted mutations (PAM) matrices, Blocks amino acid substitution matrices (BLOSUM)
4. Gaps and gap penalties

**UNIT-IV**

**Genomics and proteomics**

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1. Genomics: Definition, history and classification (structural, functional and comparative)
2. Proteomics: Definition, metabolomics, classification (protein expression profiling, functional and structural), data mining
3. Significance of genomics and proteomics

#### Phylogenetic analysis

1. Graphical representation, molecular clock theory
2. Monophylatic, paraphylatic and polyphyletic
3. Gene/Protein Versus species trees
4. Methods for inferring molecular phylogenies
5. Software packages for phylogenetic analysis.

#### PRACTICALS

1. Exercises related to operating systems.
2. Exercises related to word processing (file formatting, page layout, mailing, printing etc.) using MS Word.
3. Use of MS Excel sheet for data processing.
4. Use of MS Power point for slide preparation.
5. Use of search engines.
6. Retrieve the sequence for the database.
7. Genome sequencing techniques.
8. Exercise based on various methods of sequence alignment.
9. Nucleotide and protein sequence databases.
10. Gene bank flat file format.
11. Data mining in proteomics.
12. Web based tools for sequence searchers and homology screening.

#### SUGGESTED BOOKS

1. Introduction to Bioinformatics, Attwood, T. K. and Parry Smith D. J., Pearson Education, Singapore 2006.
2. Structural Bioinformatics, Bourne P. E. and Weissig, H. Wiley-Liss New Jersey, USA. 2003
3. Introduction to Bioinformatics, Lesk A. M. 2<sup>nd</sup> ed., Oxford Press, 2005.
4. Fundamental Concepts of Bioinformatics, Kranc Dan E. Pearson education (Singapore) Pte. Ltd, 2005.
5. Beginning Perl for Bioinformatics, Tisdall J. D. O'reilly, California, USA 2001.
6. Bioinformatics: Sequence and Genome Analysis, Second edition Cold Spring, David W. Mount, Harbor Laboratory Press, New York 2004.
7. Statistical Bioinformatics: A Guide for Life and Biomedical Science Resarchers, Jae, K. Lee John Wiley & Sons, New York 2010.
8. Francis Ouellette Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis and B. F. John Wiley & Sons, New York 2004.
9. Structural Bioinformatics, Jenny Gu and Philip E. Bourne Wiley Blackwell, 2009.
10. International I. Bioinformatics: Concepts, Methodologies, Tools, and Applications edited by information Resources Management Association, IGI Global publishers 2013.
11. Handbook of Statistical Bioinformatics Henry Horng-Shing Lu, Bernhad Scholkopf and Hongyu Zhao, Springer publishers, 2011.
12. Computer Fundamentals, Architecture & Organisation. Ram B. and Kumar S. 5<sup>th</sup> edition. New Age International (P) Ltd., New Delhi, 2014

Dr. Mohan  
 Professor  
 University of Rajasthan  
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13. Bioinformatics Methods and Protocols, Krawetz Stephen Misener and Stephen A. Humana press Inc 1999.

**M. Sc. ZOOLOGY I SEMESTER  
ELECTIVE  
ZOL E102: GENETICS**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

1. Brief life history of Gregor John Mendel.
2. Laws of Inheritance, modified Mendelian ratios, Lethal genes, Co-dominance, Incomplete dominance.
3. Pedigree analysis
4. Multiple allelism.
5. Pleiotropism.
6. Chromosome theory of inheritance.

**UNIT-II**

**Sex-determination and sex-linked inheritance**

1. Sex -determination in Humans, *Drosophila*.
2. Sex linked Inheritance: Hemophilia, colour blindness, baldness in man.
3. Sex chromatin and drum sticks

**Linkage and crossing over**

4. Crossing over: Concept and significance, Linkage disequilibrium and recombination.
5. Linkage: Concept & history, complete & incomplete linkage, Bridge's experiment, coupling & repulsion, recombination frequency, Basic concept of dosage compensation, linkage maps based on two factor crosses.

**UNIT-III**

1. Genetic code; repetitive and unique DNA sequences, split genes, overlapping genes and pseudo genes.
2. Gene interactions: Lethal alleles, penetrance and expressivity, pleiotropism, modifiers, atavism, phenocopies.
3. Genetic control of cell division; Proto-oncogenes, Oncogenes and Tumor suppresser genes.
4. Transposable genetic elements.
5. Molecular mechanism of mutation, forward and reverse genetic mutations at DNA and protein level, frame shift mutation, extragenic suppression, physiological suppression.
6. Extranuclear inheritance, maternal effect, organelle heredity, infection heredity.

**UNIT-IV**

1. Cytogenetics of human chromosomes.
2. Inbreeding and related disorders; Other genetic diseases.
3. Molecular diagnosis of genetic diseases (Cystic fibrosis, Huntington's disease and sickle

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- cell anemia), Screening of risk factor for genetic diseases.
- Elementary idea of gene therapy.
  - Behavioral genetics, circadian rhythm in *Drosophila*.
  - Human genome project.

### PRACTICALS

- Gene interactions with the help of *Drosophila* culture for the following dihybrid F<sub>2</sub> segregation ratios: 9:7; 9:4:3; 13:3; 12:3:1.
- Construction of linkage map based on recombination frequency data obtained from a two point cross from real life data.
- Chi-square analysis of a dihybrid F<sub>2</sub> population data.
- Study of meiosis in testes of grasshopper.
- Pedigree analysis of hemophilia in Royal family of Great Britain.
- Colour blindness: Ishihara's chart.
- Study of the following with the help of photographs: Sex chromosome in *Melandrium/Coccinia*, multivalent, inversion Bridge, laggards, translocation ring (*Rhoeo*), human genetic syndromes (Down's, Turner's, Klinefelter's), Barr bodies.
- Preparation of Chromosome plate from bone marrow of laboratory mice.

### SUGGESTED BOOKS

- Principles of Genetics, Grdner E.J., VIII edition, Simmons M.J. and Snustad D.P. Willey India, 2008.
- Concepts of Genetics. XI edition. Klug WS, Cummings M.R., Spencer C.A. Benjamin Cummings, 2009.
- Genetics- A Conceptual Approach. Pierce B.A. W.H. Freeman & Co., NY, 2008.
- A Conceptual Approach. Russell P. J. III edition. Benjamin Cummings, 2009.
- Genetics of populations, Hedrick, R. W. Jones and Bartelt publisher, Sudbury, Massacluselts.
- Human Genetics: problems and approaches, Vogel F and Motulsky A. Springer Verlof, 1997.
- Human Molecular Genetics, Strachan T and Read A, III ed. Garland Science, 2003.

**M. Sc. ZOOLOGY I SEMESTER  
ELECTIVE  
ZOL E103: APPLIED ZOOLOGY**

**Max. Marks: 100**

**Total Hours: 60**

#### UNIT-I

- Economic importance of beneficial and harmful Protozoa, helminthes, mites and ticks, crustaceans and spiders.
- Insects as pollinators, ornamental insects; insects as food.
- Industries related to Lac insect, Honey bees and Silk worm.
- Disease causing insects (in man and animals) and their control.

#### UNIT-II

- Fresh and Brackish water fish culture.

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2. Products of fishing industry.
3. Common freshwater and marine food fishes of India.
4. Freshwater aquarium, common freshwater aquarium fishes.
5. Fishing methods in India.
6. Larvicidal fishes of India.
7. Prawn culture
8. Pearl culture.

#### UNIT-III

1. Poultry keeping and Duck poultry.
2. Dairy farming and Piggery.
3. Leather industry, wool industry, fur and fur industry.

#### UNIT-IV

1. Pharmaccuticals from animals.
2. Economic importance of snakes
3. Economic importance of mammals.
4. Stored grain pests, polyphagous pests

#### PRACTICALS

1. General introduction to stains, preservatives and fixatives.
2. Museum specimens:
  - (i) Protozoa- Selected species of economic importance
  - (ii) Platyhelminthes : Selected species of economic importance
  - (iii) Arthropoda: Mites, Ticks, Spiders, Insects
  - (iv) Molluscs, Echinoderms, fishes, snakes and mammals
3. Visit to Poultry farm /dairy (Report to be submitted).
4. Collection and preservation of pest of economic importance (Detailed life history)
5. Visit to leather / wool / fur industries (Report to be submitted).
6. Study of protozoan, Helminth parasites and arthropod vectors associated with human disease.

#### SUGGESTED BOOKS

1. Economic Zoology, G.S Shukla & V.B. Upadhyay, Rastogi Publications, Meerut, India 1991-92.
2. Fish & Fisheries, Kamaleshwar Pandey & J.P Shukla. Rastogi Publications, Meerut, India 2007.
3. Fish & Fisheries, of India, V.G. Jhingran, Hindustan Pub, Corp. India 1982.
4. A Hand Book on Economic Zoology, Jawid Ahsan and Subhas Prasad Sinha, S. Chand & Company Ltd. Ramnagar.

M. Sc. ZOOLOGY I SEMESTER  
ELECTIVE  
ZOL E104: TOXICOLOGY

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Max. Marks: 100

Total Hours: 60

### UNIT-I

#### Fundamentals of toxicology

1. Definition, scope and basic divisions of toxicology.
2. Basic concept of Toxicology: Toxicants and toxicity; Factors affecting environmental concentrations of toxicants; Factors influencing toxicity.
3. Dose; Effect and response; Dose-response relationships; Statistical concepts of toxicity; Margin of safety (Slope); Toxicity curves; Cumulative toxicity.
4. Toxicological testing methods: General test design; Single species tests; Multispecies tests; Acute, Subacute and Chronic toxicity tests.
5. Concept of QSAR, Toxicogeomics, Metabonomic technology, Molecular toxicology and Chronotoxicology.

### UNIT-II

#### Toxicants of public health

1. Toxic chemicals and their effects: Pesticides; Heavy metals; Fertilizers; Food additives;
2. Radioactive substances; Automobile emissions.
3. Membrane permeability and mechanisms of chemical transfer; Absorption and translocation of xenobiotics; Membrane barriers, binding of xenobiotics and storage depots; Excretion of xenobiotics.
4. Toxic chemicals in the environment; Bioconcentration and Biomagnification.
5. Occupational diseases: Pneumoconiosis (Silicosis, Anthracosis, Byssinosis, Bagassosis, Asbestosis, Farmers lung), Plumbism and Occupational dermatitis.

### UNIT-III

#### Biotransformation of toxicants

1. Definition and Biotransformation sites.
2. Phase I reactions: Oxidation, Reduction and Hydrolysis.
3. Phase II Reactions: Glucuronide formation, Methylation, Sulphate conjugation, Acetylation, Amino acid conjugation and Glutathione conjugation.
4. Complex nature of biotransformation, Factors affecting biotransformation and Bioactivation.

### UNIT-IV

#### Natural Toxins and their health effects

1. Microbial toxins: Anthrax, Botulism, Staphylococcal Enterotoxin, Mycotoxicosis, Mushrooms.
2. Venoms of invertebrates: Sponges, Coelenterates, Annelids, Arthropods, Molluscs and Echinoderms.
3. Venoms of Vertebrates: Fishes, Amphibians and Reptiles (lizards and snakes).
4. Neurotoxic plants: Hemlock (*Conium maculatum*), Water hemlock (*Cicuta virosa*), Curare (*Chondrodendron tomentosum*).
5. Cyanogenic plants: Hydrangea (*Hydrangea paniculata*), Apricot, Cassava (*Manihot esculenta*).

6. Poisonous plants: Castor (*Ricinus communis*), Rosary pea (*Abrus precatorius*), Oleander (*Nerium oleander*), Azalea (*Rhododendron*)

### PRACTICALS

1. Determination of LC<sub>50</sub>/LD<sub>50</sub> of any toxicant using organisms.
2. Study the effects of toxicants on blood cells and blood biochemistry.
3. Study the effects of toxicants on liver function enzymes such as, Alkaline phosphatase, SGPT and SGOT.
4. Study the effects of toxicants on kidney function.
5. Study the effects of toxicants on enzyme Acetylcholinesterase.
6. Study the effects of toxicants on chromosome of various organisms.
7. Study the protein profile of various tissues of toxicant exposed animals.
8. Histopathological/histochemical study of liver, kidney, brain and GIT after exposing suitable experimental organisms exposed to various toxicants.
9. Study of various natural toxins producing organisms (microbes, plants and animals) based on syllabus.
10. Writing report on any one type of occupational hazardous event in the past.

**Note:** It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

### SUGGESTED BOOKS

1. Fundamentals of Toxicology, Casseret and Doulls; Curthis Klassen 1997.
2. Environmental Pollution, Health and Toxicology. S. V. S Rana, Narosa Publishing House, New Delhi.
3. Fundamentals of Toxicology. Kamleshwar Pandey, J. P. Shukla, S. P. Trevedi. New Central Book Agency (p) Ltd.
4. Environmental Biology and Toxicology. P. D. Sharma. Rasthogi Publications.

**M. Sc. ZOOLOGY I SEMESTER  
ELECTIVE  
ZOL E105: BIOSAFETY AND BIOETHICS**

**Max. Marks: 100**

**Total Hours: 60**

### UNIT-I

#### Bio-safety

1. Definition, requirement, bio-safety containment facilities.
2. Bio-safety against infectious agents/microorganisms; bio-safety levels for infectious agents and infected food/animals.
3. Introduction to biological safety cabinets; biohazards, biosafety for human health and environment.

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4. Designing and management of laboratory and culture room as per the norms of GLP, GMP and FDA.

## UNIT-II

### Bio-safety issues

1. Social issues: Genetic discrimination: insurance and employment, human cloning, foeticide, sex determination.
2. Ethical issues: Somatic and germ line gene therapy, clinical trials, ethical committee function, social and ethical issues.
3. Issues related with GMOs, the risk of introducing genetically engineered organisms to environment- ecological safety.
4. Indian government bio-safety guidelines, role of RCGM (review committee on genetic manipulation), role of GEAC (genetic engineering approval committee).
5. Role of IBSC (institute bio-safety committee) in research and development of GMOs (transgenics), in medicine, food and agriculture; guidelines for environmental release of GMOs; risk assessment, risk management.

## UNIT-III

### Bioethics

1. History, development of discipline, objectives and scope.
2. Principles of bioethics.
3. Medical ethics.
4. Perspectives and methodology.

### Biotechnology ethics

1. Human problems.
2. Animal rights, animal welfare.
3. Biotechnology and experimental animals, ethical issues of transgenic animals.
4. Religious views of transgenic animals.

## UNIT-IV

### Ethics in animal research

1. Research areas of medicine and biology based on animal experiments.
2. Animal welfare measures: International scenario, INSA guidelines, CPCSEA guidelines, Animal Welfare measures through legislation.
3. Issues related to animal experiments, the 3Rs.
4. Scenario in India.
5. Institutional Animal Ethics Committee (IAEC), composition and function.

### PRACTICALS

1. Study of biosafety equipments (biosafety cabinets, etc.).

2. Study of laminar flow hood and sterilization equipments (dry air oven, autoclaves, sterilisers, etc.).
3. Handling of laboratory animals.
4. Study of transgenic organisms.
5. Study of laboratory and culture rooms.
6. Visit to laboratory animal facilities.
7. Study of important cases related to ethical issues.

### SUGGESTED BOOKS

1. Biological Safety: Principles and Practices (Biological Safety: Principles & Practices). Diane O., Ph.D. Fleming and Debra Long Hunt (Aug 30, 2006).
2. ICH Hormonal Tripartite Guidelines for Good Clinical Practice. Schedule Y-Ethical Guidelines for Biomedical Research on Human participants. ICH-technical Coordination-R. Press, London, UK.
3. Use of Animals in Scientific Research. V. Giridharan, Vijay Kumar and Vasantha Muthuswamy, ICMR, New Delhi, 2000.
4. Guidelines for Care and Use of Animals in Scientific Research. Indian National Science Academy (1992) (revised-2000).
5. Biomedical Research: Understanding the Issues. American Association For Laboratory Animal Science, Crestwyn Hills Drive, Memphis.
6. Standard Operating Procedures for Institutional Animal Ethics Committee (IAEC). Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Animal Welfare Division, Ministry of Environment and Forests, Govt. of India, New Delhi, 2010.
- 7.

**M. Sc. ZOOLOGY I SEMESTER  
ELECTIVE  
ZOL E106: PARASITOLOGY**

**Max. Marks: 100**

**Total Hours: 60**


### UNIT-I

#### Introduction to parasitology

1. History of parasitology.
2. General idea of life cycle of parasites.
3. Types of development of parasitic forms and alternation of generation.
4. Development of parasite in tissue system.
5. Mechanism of pathogenicity.
6. International Zoological Nomenclature as applicable to parasites.
7. Economic importance of taxonomic study of parasites.

### UNIT-II

#### Parasitic Protozoa

  
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1. Classification of parasitic protozoa.
2. Structure, life history, pathogenicity, treatment and management of: *Trypanosoma brucei gambiense*, *T.b. rhodensiense*, *T. cruzi*, *T. lewisi*, *Leishmania donovani*, *Giardia lamblia*, *Trichomonas tenax* and *Trichomonas vaginalis*.
3. Structure, life history, pathogenicity, treatment and management of: *Entamoeba coli*, *E. gingivalis*, *E. histolytica* and *E. muris*.
4. Structure, life history, pathogenicity, treatment and management of: *Eimeria tenella*, *Gregarinia*, *Monocystis lumbrici*, *Plasmodium vivax*, *P. ovale*, *P. malaria* and *P. falciparum*.

### UNIT-III

#### Parasitic Helminthes

1. Classification of the parasitic helminthes.
2. Structure, life history, pathogenicity, treatment and management of: *Fasciola hepatica*, *Fasciola buski*, *Schistosoma haematobium*, *Schistosoma mansoni* and *Schistosoma japonicum*.
3. Structure, life history, pathogenicity, treatment and management of: *Taenia solium* and *T. saginata*.
4. Structure, life history, pathogenicity, treatment and management of: *Ascaris lumbricoides*, *Trichinella spiralis*, *Trichuris trichiura*, *Dracunculus medinensis* and *Wuchereria bancrofti*.

### UNIT-IV

#### Parasitic Annelids and Arthropods

1. Classification of parasitic Annelids and Arthropods.
2. Structure, life history, pathogenicity, treatment and management of: *Glossiphonia*, *Pontobdella* and *Hirudo medicinalis*.
3. Structure, life history, pathogenicity, treatment and management of: *Pediculus humanus capitis*, *Pediculus humanus corporis*, *Phthirus pubis*, *Cimex lectularius*, Mites, Ticks, Cattle louse and *Xenopsylla cheopis*.

#### PRACTICALS

1. Examination of blood for parasites.
2. Detection of exflagellation (microgamete formation in Plasmodium).
3. Examination of blood for microfilarial infection (Papanicolaou-hematoxylin and eosin).
4. Permanent slides: *Trypanosoma brucei gambiense*, *T.b. rhodensiense*, *T. cruzi*, *T. lewisi*, *Leishmania donovani*, *Giardia lamblia*, *Trichomonas tenax*, *Trichomonas vaginalis*, *Entamoeba coli*, *E. gingivalis*, *E. histolytica*, *E. muris*, *Eimeria tenella*, *Gregarinia*, *Monocystis lumbrici*, *Plasmodium vivax*, *P. ovale*, *P. malaria*, *P. falciparum*, *Fasciola hepatica*, *Fasciola buski*, *Schistosoma haematobium*, *Schistosoma mansoni*, *Schistosoma japonicum*, *Taenia solium*, *T. saginata*, *Ascaris lumbricoides*, *Trichinella spiralis*, *Trichuris trichiura*, *Dracunculus medinensis*, *Wuchereria bancrofti*, *Glossiphonia*, *Pontobdella*, *Hirudo medicinalis*, *Pediculus humanus capitis*, *Pediculus humanus corporis*, *Phthirus pubis*, *Cimex lectularius*, Mites, Ticks, Cattle louse and *Xenopsylla cheopis*.

#### SUGGESTED BOOKS

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1. Textbook of Medical Parasitology. Chakraborty P. New Central Book Agency (P) Ltd., Kolkata.
2. Parasitology. Chatterjee K.D.
3. Parasitology. Dasgupa, B., Books and Allied Pvt. Ltd., Calcutta.
4. Essential of Parasitology. Schmidt G.D. Universal Book Stall, New Delhi.

### ZOL 112: PRACTICAL-II

(BASED ON ZOL E101/ ZOL E102/ ZOL E103/ ZOL E104/ ZOL E105 / ZOL E106)

#### Scheme for Practical Examination

	Max. Marks: 100	Time: 6 hrs
1.	Exercise 1	16
2.	Exercise 2	16
3.	Exercise 3	16
4.	Spotting (8 × 3)	24
5.	Seminar	09
6.	Viva Voce	10
7.	Record	09

#### Notes:

1. Anatomy: Study of systems of the prescribed types with the help of dissection.
2. With reference to Museum specimens and microscopic slides, in case of non-availability, the exercise should be **substituted with diagrams / photographs.**
3. **It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.**

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M.Sc. ZOOLOGY II SEMESTER (2023-2024)  
CORE PAPER  
ZOL C201: PHYSIOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

**Digestive system:**

1. Nature of food-stuff
2. Various types of digestive enzymes and their action in alimentary canal
3. Absorption and assimilation of food
4. Nervous and hormonal control of digestion
5. Energy balance

**Circulatory system:**

1. Composition and function of blood
2. Haemopoiesis, blood clotting
3. Blood volume, blood volume regulation
4. Comparative anatomy of heart structure
5. Myogenic heart, ECG – its principle and significance, cardiac cycle
6. Heartbeat, blood pressure and blood groups

**Respiratory system:**

1. Respiratory organs (gills, trachea and lungs), respiratory pigments
2. Mechanism of breathing
3. Physiology of respiration, control of breathing
4. Aerodynamics and BMR

UNIT-II

**Excretory system:**

1. Comparative physiology of excretion
2. Functional architecture of kidney and nephron
3. Nitrogenous end products, formation of urine and its hormonal control
4. Role of kidney in osmoregulation, urine concentration
5. Waste elimination, micturition
6. Electrolyte balance, acid-base balance

**Muscular system:**

1. Types and properties of muscles
2. Functional architecture of skeletal muscles
3. Biophysical and biochemical events during muscular activity

**Nervous system:**

1. Functional architecture of neurons
2. Origin and propagation of nerve impulse through axon
3. Action potential, synaptic transmission
4. Reflex arc and reflex action
5. Gross neuro-anatomy of the brain and spinal cord
6. Central and peripheral nervous system
7. Neural control of muscle tone and posture

UNIT-III

**Sense organs:**

1. Structural architecture and functioning of eyes and ears
2. Tactile response

**Thermoregulation and cold tolerance:**

1. Heat balance and exchange, endotherms Vs ectotherms
2. Counter-current heat exchanger
3. Torpor, hibernation and aestivation
4. Adaptations to extreme climate
5. Comfort zone, body temperature- physical, chemical and neural regulation

**Stress:**

1. Basic concepts of environmental stress and strain
2. Homeostasis, physiological response to body exercise
3. Meditation, yoga and their effects

**UNIT-IV**

**Endocrinology:**

1. Endocrine glands in vertebrates, hormones and related diseases

**Reproduction:**

1. Reproductive cycle.
2. Reproductive processes (implantation, parturition and lactation), neuroendocrine regulators in insects and mammals, pheromones.

**Practicals**

1. Photometric determination of haemoglobin in blood sample.
2. Determination of MCV, MCH, MCHC and colour index of the given sample of blood.
3. Demonstration of the blood clotting time and erythrocyte sedimentation rate.
4. Determination of the urea in blood.
5. Determination of the glucose in blood.
6. Liver function test: SGOT & SGPT.
7. Study of digestive enzymes in different parts of the alimentary canal.
8. Study of histological slides of endocrine glands.
9. Study of estrus smear.
10. Demonstration of location of endocrine glands in rat.
11. Measurement of human blood pressure.
12. Demonstration of haemolysis and crenation.
13. Demonstration of Kymographic recording of the frog heart beat and the study of the effect of electrical stimulation, hot and cold, drugs, etc\*
14. Kymographic recording of muscle twitch, summation of twitches, chronic contractions, tetanus, fatigue and stair-case phenomenon from the sciatic nerve gastronemius muscle preparation of frog.\*
15. Study of spinal and convulsive reflexes in frog\*  
Following CAL exercise may be included (please see E-pharm programme).
  - The effect of  $K^+$ ,  $Ca^{++}$ , ACh and Epinephrine on the isolated heart of frog and conclude your data with the graphic representation.
  - The effect of various doses of ACh and Nor-epinephrine on Blood pressure, Heart Rate and Respiratory Rate of the dog with the help of softwares.
  - The effects of Atropine, Epinephrine, Ephedrine and Eserine on Rabbit's eyes and other such exercise can be framed from the E-Pharm software.

**Note :** \* indicates use of Computer softwares.

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- It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

#### SUGGESTED BOOKS

1. Animal Physiology Mechanisms and Adaptation. R. Eckert (ed), 5th edition, W.H. Freeman and Company, New York.
2. Biochemical Adaptation. P.W. Hochachka and G.N. Somero (eds), Princeton Univ. Press, Princeton, New Jersey.
3. General and Comparative Animal Physiology, W.S. Hoar (ed), Prentice Hall of India.
4. Animal Physiology: Adaptation and Environment, K.S. SchiemdtNielsen (ed), University Press, Cambridge, UK.
5. A regulatory Systems Approach. Strand, F.L. Physiology: Macmillan Publishing Co., New York.
6. Practical Biochemistry, L. Lummer (ed), Tata McGraw Hill
7. Environmental and Metabolic Animal Physiology, C.L. Prosser (ed), Wiley-Liss Inc., New York.
8. Environmental Physiology, P. Willmer, G. Stone, and I. Johnson (eds), Blackwell Publishing, Oxford, UK.
9. Adaptation to Environment: Essays on the Physiology of Marine Animals. R.C. Newell (ed), 1976. Butterworths, London, UK.
10. Physiological Ecology: An evolutionary approach to resource use. Townsend, C.R. and P. Cawlow. Blackwell Sci. Inc. Pub., Oxford, UK.
11. Optima for Animals. R.M. Alexander (ed), Princeton Univ. Press. Princeton, New Jersey.
12. Comparative Physiology: Life in water or land. P. Dejours, L. Bolis, C.R. Taylor and E.R. Weibel (eds), Liviana Press, Padova, Italy.
13. Animals and Temperature: Phenotypic and Evolutionary Adaptation. I.A. Johnson & A.F. Bennett (eds), Cambridge Univ. Press, Cambridge, UK.
14. Physiological Animal Ecology. G.N. Louw, Longman Publishing Group, Harloss, UK.
15. An Introduction to General and Comparative Endocrinology, E.J.W. Barrington (ed), Clarendon Press, Oxford.
16. Comparative Vertebrate Endocrinology. P.J. Bentley (ed), Cambridge University Press.
17. Text Book of Endocrinology, R.H. Williams (ed), W.B. Saunders, Company, Philadelphia.
18. Endocrine Physiology. C.R. Martin (ed), Oxford Univ. Press, New York.
19. Comparative Endocrinology, A. Gorbman, New York: John Wiley and Sons.

**M. Sc. ZOOLOGY II SEMESTER  
CORE PAPER  
ZOL C202: MOLECULAR BIOLOGY**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**DNA:**

1. Equivalence rule.
2. Primary & secondary structure.

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3. Unusual secondary structure (slipped & cruciform structure; triple helix DNA; tetraplex) and G-quadruplex.
4. Types (A-, B- & Z-DNA) and flexibility.
5. Forces stabilizing the structure: Denaturation & renaturation; base pairing, hydrophobic interactions & ionic interactions.
6. Tertiary structure (super coiled DNA, twisting number, writh, linking number & topoisomerases).
7. Packaging of DNA: Nucleosome, solenoid & scaffold.

**DNA replication:**

1. Prokaryotic and Eukaryotic replication.
2. Mechanics of DNA replication including end replication.
3. Enzymes and accessory proteins involved in DNA replication.
4. Drugs that effect replication.

**UNIT-II**

**RNA and transcription:**

1. Types & structural features (mRNA, tRNA & rRNA).
2. Prokaryotic transcription.
3. Eukaryotic transcription.
4. Regulatory elements and mechanisms of transcription regulation.
5. Transcription termination-attenuation and antitermination.
6. Drugs inhibiting transcription.
7. Gene silencing.

**Post- transcriptional modifications in RNA:**

1. 5'- Cap formation.
2. End processing and polyadenylation.
3. Splicing and editing.
4. Nuclear export of mRNA.
5. RNA stability.
6. Inhibitors of RNA synthesis.

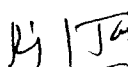
**UNIT-III**

**Translation:**

1. Genetic code.
2. Prokaryotic and eukaryotic translation.
3. Regulation of translation.
4. Co- and post-translation modifications of proteins.
5. Inhibitors of protein synthesis.

**Organelles and protein sorting:**

1. Endoplasmic reticulum
  - (i) Targeting proteins to and across ER membrane.
  - (ii) Insertion of membrane proteins into ER.
  - (iii) Protein modification, folding and processing in ER.
2. Mitochondria & Chloroplast
  - (i) Targeting of proteins.
3. Golgi apparatus
  - (i) Glycosylation.

  
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- (ii) Protein sorting & export.
  - (iii) Mechanism of vesicular transport.
4. Lysosomes
    - (i) Endocytosis and lysosome formation, phagocytosis & autophagy.
  5. Peroxisomes
    - (i) Assembly.
    - (ii) Sorting of peroxisomal proteins.

#### UNIT-IV

##### Recombination and repair:

1. Homologous recombination-Holliday model & ds break repair model
2. Homologous recombination protein machinery –Rec BCD pathway, RecA, Ruv AB complex &Ruv C.
3. Homologous recombination in eukaryotes- Meiosis.
4. FLP/FRT and Cre-Lox recombination.
5. DNA repair mechanisms- Radiation damage, Direct reversal, Oxidative damage, Alkylation, Base excision repair, Nucleotide excision repair, Mismatch repair, ds break repair, SOS response and Translesion DNA synthesis.

##### Eukaryotic genomes:

1. C-value paradox.
2. Reassociation kinetics.
3. Non repetitive DNA complexity.
4. Repetitive sequences.
5. Structural genes (as present in mRNA)- Existing gene number by kinetics of RNA driven reactions.
6. Structural genes- Internal organizations.

##### Practicals

1. Study of polytene chromosome in salivary gland of chironomus larva / Drosophila III<sup>rd</sup> instar larva using acetocarmine.
2. Identification of mitochondria using vital stains (Neutral Red & Janus Green B).
3. Electrophoresis:
  - (i) DNA molecular size determination.
  - (ii) Extraction & purification of DNA from gel.
  - (iii) Extraction & isolation of genomic DNA from bacteria / Yeast / human cheek cells.
  - (iv) Experiments using restriction enzymes & DNA ligase.
  - (v) Isolation of RNA from bacteria.
4. Isolation of genomic DNA.
5. Extraction and quantitative estimation of DNA.
6. Study of permanent slides-Squamous cells, columnar epithelial cells, nerve fibre, striated and unstriated muscle cells, connective tissue

**Note:It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.**

##### SUGGESTED BOOKS

1. Essential Cell Biology, Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K and Walters P. 4<sup>th</sup> edition. Garland Science Publishing New York U.S.A, 2013.
2. Molecular Biology of the Cell. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P. 5<sup>th</sup> edition. Garland Science, 2007.
3. Molecular Biology of the Cell. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. 4<sup>th</sup> edition. Garland Science, 2002.
4. Genomes, Brown TA. 2<sup>nd</sup> edition. Oxford: Wiley-Liss, 2002.
5. Genomes 3, Brown TA. Garland Science, 2006.
6. Molecular Cell Biology. Darnell J. 5<sup>th</sup> edition. W.H Freeman and Company, New York, 2004.
7. Cell and Molecular Biology. De Robertis EDP and De Robertis Jr EMF. 8<sup>th</sup> edition, Lippincott Williams & Wilkins. 2006.
8. Molecular biotechnology. Glick BR and Pasternak JJ. Principles and Applications of Recombinant DNA. ASM Press Washington DC, 1998.
9. Cell Biology. Karp G. 6<sup>th</sup> edition, Hoboken, NJ: Wiley 2013.
10. Essential Genes. Levin B. Pearson Higher Education. International edition. 2006.
11. Genes IV. Lewin B. Oxford University Press Bombay, 1990.
12. Genes V. Lewin B. International Students Edition. Oxford University Press Oxford, 1994.
13. Genes VII. Lewin B. Oxford University Press, Oxford, 2000.
14. Genes VIII. Lewin B. Pearson Education International. London, Sydney, 2004.
15. Molecular Cell Biology. Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, Matsudaira P. 6<sup>th</sup> edition W.H Freeman and Company, New York, 2008.
16. Molecular cell Biology. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Scott MP, Zipursky SL, Darnell J. 5<sup>th</sup> edition. W.H Freeman and Company, New York, 2004.
17. Molecular Cell Biology. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D, Darnell J. 4<sup>th</sup> Edition, W.H Freeman and Company, New York, 2000.
18. Molecular Cell Biology. Lodish H, Berk A, Kaiser CA, Krieger M, Bertscher A, Ploegh H, Amon A, Scott M P. 7<sup>th</sup> edition. Mac Millian High Education (International edition), England, 2013.
19. Molecular Biology and Biotechnology. Meyers R.A. A Comprehensive Desk Reference. VCH Publishers, 1995.
20. Principles of gene manipulation and Genomics. Primrose SB and Twyman RM. 7<sup>th</sup> edition. Blackwell Publishing, USA, 2006.
21. Human Molecular Genetics. Strachan T and Read AP. 2<sup>nd</sup> edition. New York: Wiley-Liss; 1999.
22. Molecular Biology. Tropp BE. Genes to Proteins, 3<sup>rd</sup> edition. Jones & Bartlett Publishers, Sadbury Massachusetts, 2008.
23. Watson ID, Hoopins NH, Roberts JW, Steiz JA and Weiner AM. Molecular Biology of Gene. 4<sup>th</sup> edition. The Benjamin/Cummings Publishing Company, Inc, USA, 1998.
24. Recombinant DNA. Watson JD, Gilman M, Witkowski J and Zoller M. 2<sup>nd</sup> edition. W.H Freeman and Company, New York, 1992.
25. Molecular Biology. Weaver R.F. 2<sup>nd</sup> edition. McGraw Hill Company, New York, NY, 2002.
26. Molecular Biology, Weaver, R.F. 3<sup>rd</sup> edition, McGraw-Hill Company, New York, NY, 2005.

M. Sc. ZOOLOGY II SEMESTER  
CORE PAPER  
ZOL C203: BIOSTATISTICS

Max. Marks: 100

Total Hours: 60

UNIT-I

**Introduction to Biostatistics:**

1. Definition of biostatistics
2. Scope and applications of biostatistics
3. Collection, organization and representation of data (graphical- Bar, Histogram, Frequency polygon, line diagram & diagrammatic)

**Measures of Central Tendency & Variability ( Direct, Shortcut and Step-deviation)**

1. Mean, median & mode
2. Mean deviation
3. Standard deviation & standard error
4. Variance & coefficient of variation
5. Confidence interval and level of confidence

UNIT-II

**Correlation and Regression:**

1. Types of correlation
2. Methods of studying correlation
3. Regression analysis

**Probability:**

1. Basic concepts related to probability theory.
2. Classical, Posteriori, Personalitic & Axiomatic probability.
3. Theorems of probability & Probability distributions.
4. Properties of Binomial, Poisson, Normal and skewed distribution & their application in biology.

UNIT-III

**Tests of significance:**

1. Hypothesis testing & level of significance
2. Type I & II errors
3. Significance of difference in means
4. Z-test
5. Student's t-test (Unpaired & Paired)
6. F-test (variance ratio)

**Analysis of variance:**

1. One way classification
2. Two way classification

UNIT-IV

Chi square test:

1. Testing Goodness of fit
2. Chi Square distribution and characteristics
3. Applications of Chi-square test
4. Yate's correction



### Computational statistics using MS Excel

#### Practicals

1. Preparation of frequency tables, bar diagrams, histograms, frequency, ogives and pi-diagrams.
2. Calculation of mean, median, mode, standard deviation and coefficient of variation.
3. Estimation of probability.
4. Estimation of significance between samples using Student's t-test, F-test and Chi-square test.
5. Plotting of scatter diagrams & regression lines, calculation of correlation and regression analysis.
6. Use of MS Excel spread sheet for data processing.
7. Preparation of graphs using computers

#### SUGGESTED BOOKS

1. Introduction to Bioinformatics, Attwood, T. K. and Parry Smith D. J. (2006) Pearson Education, Singapore.
2. Fundamentals of Biostatistics, 7<sup>th</sup> edition, Bernard Rosner (2011) Cengage learning Inc.
3. Structural Bioinformatics, Bourne P. E. and Weissig, H. (2003) Wiley –Liss New Jersey, USA.
4. Elementary Statistics: A Breif Version (5<sup>th</sup>ed.) Bulman A. (2012) McGraw-Hill Higher Education.
5. Biostatistics: The Bare Essential 3<sup>rd</sup> edition, Geoffrey R. Norman and David L. Streiner (2008) BC Decker Inc.
6. Biostatistics: A Methodology for the Health Sciences, Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty and Thomas Lumley (2004) John Wiley & Sons, New Jersey.
7. Sampling Design and Statistical Methods for Environmental Biologist, Green R. H. (1979) John Wiley & Sons, Newyork.
8. Biostatistical Analysis 5<sup>th</sup> edition, Jerrold H. Zar (2010) Pearson Education, Singapore.
9. Biostatistical Methods: The Assessment of Relative Risks 2<sup>nd</sup> edition, John M. Lachin (2010) John Wiley & Sons, Newyork.
10. Basic Epidemiological Methods and Biostatistics Randy M. Page, Galen E. Cole and Thomas C. Timmreck (1995): A Practical Guidebook, Jones and Bartlett publishers.
11. Biometry: The Principles and Practices of Statistics in Biological Research, Sokal R. R. and Rolf F. J. (2003) W. H. Freeman publishers.

  
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**ZOL 211: PRACTICAL-III**  
(BASED ON ZOL C201, ZOL C202 and ZOL C203)

**Scheme for Practical Examination**

<b>Max. Marks: 100</b>	<b>Time: 6 hrs</b>
1. Exercise Core 1	16
2. Exercise Core 2	16
3. Exercise Core 3	16
3. Spotting (8 × 3)	24
4. Seminar	09
5. Viva Voce	10
6. Record	09

**Note:** It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

**M. Sc. ZOOLOGY II SEMESTER**  
**ELECTIVE**  
**ZOL E201: IMMUNOLOGY**

**Max. Marks: 100** **Total Hours: 60**

**UNIT-I**


1. Historical perspective of Immunology, Early theories of Immunology, Innate, Adaptive (cell mediated and humoral)- Passive: Artificial and Natural Immunity, Active: Artificial and Natural Immunity.
2. Haematopoiesis, Cells of the immune system, Organs of the immune system: Primary and secondary lymphoid organs, Lymphatic system.

**UNIT-II**

1. Properties of antigens, Haptens, Determinants, Adjuvants.
2. Antibodies: Basic structure, classes and function.
3. Antigen- Antibody Interactions: Precipitation, Agglutination, immunoelectrophoresis, Neutralizing reactions, Complement activation (Classical, Alternative & Lectin pathway).

**UNIT-III**

1. Mechanism of cell mediated and humoral immunity.
2. MHC Structure and types, Endogenous pathway and exogenous pathway of antigen presentation.
3. Vaccine : Immunization schedule, types : attenuated and inactivated, DNA vaccine, Recombinant vaccine.

  
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#### UNIT-IV

1. Immunodeficiencies:
  - A. Phagocytic deficiencies - (i) Neutrophil deficiencies.  
(ii) Defective phagocytic functions.
  - B. Humoral Deficiencies- (i) Hyper IgM syndrome.  
(ii) X linked Agammaglobulinemia.  
(iii) Common variable hypogammaglobulinemia.
  - C. Cell Mediated Diseases- (i) DiGeorge Syndrome.  
(ii) Nude mice.
2. Hypersensitivity: Type I, II, III & IV.
3. Tolerance: General features of immunologic tolerance, T- and B-cell tolerance, induction of tolerance.

#### Practicals

1. Dissection, localization and study of lymphoid organs in rats.
2. ABO blood group determination.
3. Widal's test.
4. Ouchterlony's double immunodiffusion method.
5. Immunoelectrophoresis (Rocket electrophoresis).
6. Viability and cell counting of peritoneal macrophages using Trypan blue.
7. Study of various types of immune reactions *in vitro*.

**Note:** It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

#### SUGGESTED BOOKS

1. Principles of Biochemistry. Nelson D.L., Cox, M.M. and Lehninger, A.L. IV Edition. W.H Freeman and Co., 2009.
2. Harper's Illustrated Biochemistry. Murray R.K., Granner D.K., Mayes, P.A. and Rodwell V.W. XXVIII Edition. Lange Medical Books/McGraw-Hill., 2009.
3. Immunology. Kindt T.J, Golds R.A., Osborne B.A. and Kuby J. VI Edition. W.H. Freeman and Company, 2006.
4. Roitt's Essential Immunology. Delves P.J., Martin, S.J. Burton D.R. and Roitt, I.M. XI edition. Blackwell Publishing, 2006.

#### M. Sc. ZOOLOGY II SEMESTER ELECTIVE

#### ZOL E202: WILD LIFE, ITS MANAGEMENT AND CONSERVATION

Max. Marks: 100

Total Hours: 60

#### UNIT-I

#### Wildlife:

1. Definition and significance.
2. National park and Sanctuaries, Reserves, Hot spots and Hope spots.

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3. IUCN classification of species, red data book.

#### UNIT-II

1. Techniques of studying wild life, traditional and advanced both.
2. Endangered species of India and their present status.
3. Measures adopted by government to protect them.
4. Management of excess population and translocation, Bio-telemetry, care of injured animal and Quarantine

#### UNIT-III

1. Management of special habitats.
2. Problems in plantations and exploited forests.
3. Species conservation projects: Tiger, lion, rhino and crocodile management plan for protected areas
4. Threats to survival of slender Loris, Musk Deer, Great Indian Bustard and Olive Ridley turtle.

#### UNIT-IV

1. Wildlife and livelihood, wildlife and illegal trade, its control
2. Use of Biotechnology in Wild life conservation.
3. Captive breeding *in-situ* and *ex-situ* gene pool conservation.
4. Indian biodiversity act, economics of Indian biodiversity.
5. Wildlife protection Act 1972 its amendments and its applications.

#### Practicals

1. Study of wildlife habitat.
2. Visit to Zoological Park/ National park and sanctuaries/ reserves and hot spots.
3. Study of different type of animals in terrestrial and aquatic habitat
4. Quantitative estimation of any two species in nature by traditional method. (Insect, amphibian, reptiles or mammals).
5. Techniques of studying wildlife's and its census; traditional and advanced methods.
6. Project report -Tiger project / Ghariyal project in Rajasthan.
7. Evaluation of biodiversity : (a) Shannon-Weiner index  
(b) Dominance index.
8. Hair samples: (a) Species identification of selected mammals (minimum five, slides to be submitted).  
(b) Morphometric studies.

#### SUGGESTED BOOKS

1. Techniques for wildlife Census in India (A field manual); Rogers W.A. Wildlife Institute of India, Dehradun.

2. Wildlife Wealth of India. Majupuria T.C Tecpress Services, L.P., 487/42-SOL Wattenslip, Pratunam Bangkok, 10400, Thailand
3. Handbook of Birds, of India, Ali, S. Ripley S.D. Pakistan 10-Vols. Oxford University Press, Bombay.
4. The Book of Indian Animals. Prater S.H. BNHS-Publication, Bombay.
5. Wildlife in India. Saharia V.B. Natraj Publishers, Dehradun.
6. The Wildlife of India E.P. Gee.
7. Techniques for wildlife census in India (A Field Manual) W.A. Rogers, Wildlife Institute of India.
8. Species identification from guard hair OF SELECTED Indian mammals: A reference guide. Bahuguna A, Sahajpal V , Goyal SP, Mukherjee SK & Thakur V. Wild Life Institute of India 2010.

**M. Sc. ZOOLOGY II SEMESTER  
ELECTIVE  
ZOL E203: APPLIED BIOLOGY**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

1. Introduction to the concept of Recombinant DNA Technology.
2. Cloning vectors.
3. Restriction and modifying enzymes,
4. Transfection techniques (microbial, plants and animals).
5. Isolation, Sequencing and synthesis of genes.
6. Construction and screening of cDNA libraries.

**UNIT-II**

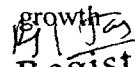
1. Molecular analysis of DNA, RNA and proteins (i.e., Southern, Northern and Western blotting), DNA sequencing (Maxam-Gilbert and Sanger methods).
2. Polymerase chain reaction and DNA microarrays.
3. Molecular map of animal genomes.

**UNIT-III**

1. Molecular diagnosis of genetic diseases (Cystic fibrosis, Huntington's disease and Sickle cell anemia).
2. Recombinant vaccines.
3. Recombinant DNA in Medicine (Recombinant insulin and Human growth hormone),
4. Gene therapy (ADA and Cystic fibrosis).
5. Stem Cells and their applications.

**UNIT-IV**

1. Production and applications of transgenic plants (biotic, abiotic and improvement of nutritional quality) and transgenic animals (generation of medicines and hormones).
2. Different types of Bioreactors and their uses.

  
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3. Use of Biotechnology in conservation of Biodiversity.

#### Practicals

1. Isolation of plasmid DNA from *E. coli*.
2. Transformation of *E. coli* (pUC 18119) and calculation of transformation efficiency.
3. Restriction Endonuclease Digestion of plasmid DNA.
4. Ligation of Target DNA.
5. Gene amplification using PCR.
6. DNA sequencing: Interpretation of sequence from the data provided.
7. Analysis of DNA fingerprint.
8. Separation of proteins by SDS-PAGE.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

#### SUGGESTED BOOKS

1. Microbiology. 5th edition Pelezar M.J. Chan E.C.S and Krieg N.R. Tata McGraw-Hill Book Co. New Delhi, 2001.
2. Preventive and Social Medicine. Park K. B.B. publishers, 2007.
3. Molecular Biotechnology- Principles and Applications of Recombinant DNA, Glick B.R. and Pasternak J. J. (2010) ASM press, Washington, 2010.
4. Recombinant DNA- Genes and Genomes- A short Course. 3rd edition. Watson J.D., Myers R.M., Caudy A., Witkowski J.K. (2007) Freeman and Co. NY, 2007.

**M. Sc. ZOOLOGY II SEMESTER .  
ELECTIVE  
ZOL E204: HISTOLOGY AND HISTOPATHOLOGY**

**Max. Marks: 100**

**Total Hours: 60**

#### UNIT-I

1. Definition and scope of histology and histopathology.
2. Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultramicrotome, problems and trouble shooting.
3. Techniques in histology: Sample preparation, obtaining tissue samples, handling reagents, fixatives, processing of fixed samples, dehydration, embedding, block making and slide preparation
4. Staining principles and demonstration techniques. Stains, dyes and dyebinding reactive groups, mordants and mordanting.

#### UNIT-II

1. Cellular Pathology; necrosis, pycnosis, apoptosis, nuclear fragmentation, fatty degeneration etc.

2. Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.
3. Skin.
4. Histology and histopathology of blood, spleen and thymus.

#### UNIT-III

1. Histology and histopathology- thyroid, parathyroid, pituitary and adrenal gland.
2. Reproductive system – male and female.

#### UNIT-IV

1. Histology and histopathology-esophagus, stomach, intestine, colon and rectum, liver, pancreas.

#### Practicals

1. Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology
2. Microscopic measurements of histological samples using micrometers and planimeters
3. PAS reaction, Alcian blue reaction, and detection *in situ*
4. Alkaline phosphatase detection *in situ*
5. Feulgen reaction
6. Sudan black B staining for lipids
7. Methyl green – Pyronin G method of detection of nucleic acids
8. Study of different types of pathology in the tissues with the help of permanent slides.

**Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.**

#### SUGGESTED BOOKS

1. Histological and Histochemical methods: Theory and Practice. 4th edition (2008), J. A. Kiernan Publisher – Scion Publishing Ltd. Oxford shire.
2. Colour Atlas of Histology. 3rd edition (2000) L. P. Gartner and J. L. Hiatt Publisher – Lippincott- Williams & Wilkins, Baltimore.
3. Histology: A text book and Atlas. 2nd edition (1989). M. H. Ross, E. J. Reith and L. J. Romrell Publisher - Williams & Wilkins, Baltimore.
4. Bailey's text book of Histology. 15th edition (1964). W. M. Copenhaver. Publisher – The Williams & Wilkins Company, Baltimore.
5. A text book of Histology (1975), Bloom and Fawcett Publisher – W. B. Saunders Company Philadelphia.
6. Histology and Cell Biology: An introduction to pathology (2002), A. L. Kierszenbaum Publisher – Mosby Inc. St. Louis USA.
7. Histopathology (2012) Guy Orchard and Brian Nation – Oxford Univ. Press.

**M. Sc. ZOOLOGY II SEMESTER  
ELECTIVE  
ZOL E205: POPULATION GENETICS**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

1. Introduction to population genetics.
2. Genetic variation, Ecological significance of molecular variations.
3. Hardy Weinbergs law of genetic equilibrium – Assumptions, predictions and derivation of Hardy Weinbergs law, testing & extensions of Hardy Weinbergs law and limitations.
4. Genetic structure of natural populations, Models explaining changes in genetic structure.

**UNIT-II**

1. Molecular phylogenetics.
2. Construction of phylogenetic tree.
3. Phylogenetic inference- Distance methods, Parsimony methods, Maximum likelihood method.
4. Immunological techniques.
5. Amino acid sequence and phylogeny.
6. Nucleic acid phylogeny, DNA – RNA hybridizations, restriction enzyme sites, nucleotide sequence comparisons and homologies.

**UNIT-III**

1. Molecular evolution
2. Gene evolution.
3. Gene duplication and divergence.
4. Evolution of gene families.
5. Molecular drive.
6. Molecular clocks.

**UNIT-IV**

1. Genetics and quantitative traits in population.
2. Estimation of heritability.
3. Molecular analysis of quantitative traits.
4. Genotype –Evolution interaction.
5. Inbreeding and Heterosis.
6. Neutral theory of molecular evolution.
7. Migration including One Way migration.

**Practicals**

1. Estimates of Heritability
  - a) Broad sense
  - b) Narrow sense
  - c) Components in Phenotypic variations

- d) Genetic variance
- e) Genetic environmental interactions
2. Hardy Weinberg Principle
  - a) Genotypic frequencies and Hardy Weinberg law
  - b) Allelic frequencies (from observed no of different genotypes at particular locus and from genotypic frequencies)
  - c) Calculation of allelic frequencies with multiple alleles and at X linked locus
3. Genetic Structure of populations
  - a) Phenotypic Frequency
  - b) Allelic frequency
  - c) Recessive and dominant characters
4. Exercises based on blood groups
5. Demonstration of microbes increment (Population Growth) by inoculating culture medium with microorganisms from soil air and water

#### SUGGESTED BOOKS

1. Evolution, Strickberger, M.W. Jones and Barlantt Publishers, Boston London
2. Evolutionary and Genetics. J.M. Oxford University Press, New York
3. Evolution Genetics Merral, D.J. Holt, Rinchart and Winston, Inc.
4. Species Evolution – The role of chromosomal change . King, M. Cambridge University Press, Cambridge.
5. A primer of Population Genetics. Hart, D.L. Suinuaer Associate, Inc. Massachusetts.
6. Evolutionary Biology , Futuyamma, D.J. Suinuaer Associate, Inc. Publishers, Sunder land
7. Genetics and Origin of Species, Dohnzhansky, Th. F.J. Alaya G.L. Stebbines and J.M. Valentine, Surjeet Publication Delhi
8. Genes and Evolution, Jha A.P. John, Publication New Delhi.

#### ZOL 212: PRACTICAL-IV

(BASED ON ZOL E201/ ZOL E202/ ZOL E203/ ZOL E204/ ZOL E205)

#### Scheme for Practical Examination

Max. Marks: 100	Time 6 hrs
1. Exercise 1	16
2. Exercise 2	16
3. Exercise 3	16
4. Spotting (8 × 3)	24
5. Seminar	09
6. Viva Voce	10
7. Record	09

**Note:** It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

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M.Sc. ZOOLOGY III SEMESTER (2023-24)

CORE PAPER

ZOL C301: BIOLOGY OF CHORDATES

Max. Marks: 100

Total Hours: 60

UNIT-I

1. Outline classification of the chordates and characters
2. Evolutionary time scale; evolutionary significance of notochord and endostyle in protochordates
3. Origin, evolution and adaptive radiation of chordates.
4. Origin, evolution and general characters of Agnatha: Ostracoderms and Cyclostomes.
5. The early Gnathostomes (Placoderms).

UNIT-II

1. A general account of the Elasmobranchii, Holocephali, Dipnoi and Crosspterygii.
2. Adaptive radiation in bony fishes.
3. Origin, evolution and adaptive radiation of Amphibia.
4. Origin and evolution of Reptiles: Seymouria and Cotylosauria; Dinosaurs
5. Skull types in Reptiles.
6. Sense organs in reptiles including vomeronasal organs.

UNIT-III

1. Origin and evolution of birds.
2. Origin of flight: Flight adaptations.
3. Flightless Birds.
4. Modifications of beak, feet and palate in birds.

UNIT-IV

1. Origin of mammals: Primitive mammals (Prototheria and Metatheria); Evolution of viviparity
2. Evolution and significance of exothermy & endothermy.
3. General account on adaptive radiations in Eutherian mammals.
4. Stomach in ruminants; evolution of primates

Practicals

1. **Anatomy:**  
Cranial Nerves of *Wallago attu* or any other locally edible fish.  
Display Weberian ossicle in fish.  
Tubular air sac of *Heteropneustus fossilis*, arboracenta organ of *Clarius*,  
labyrinthine organs of *Anabas*, suprabranchial cavity in *Channa*.
2. **Museum specimens:**  
Lower Chordates: *Salpa*-Asexual and Sexual stage, *Doliolum*- oozoid, *Botryllus*,  
*Herdmania* and *Amphioxus*, *Petromyzon*, *Myxine*.

Pisces: *Rhinobatus*, *Pristis*, *Trygon*, *Chimaera*, *Polydon*, *Acipenser*, *Amia*, *Lepidosteus*, *Protopterus*, *Lepidosiren*, *Neoceratodus*, *Notopterus*, *Exocoetus*, *Echeneis*, *Pleuronectes*, *Clarias*, *Mastacembelus*, *Diodon*, *Tetradon*, *Ostracion*, *Lophis*, *Syngnathus*, *Hippocampus*, *Anguilla*, *Labeo*, *Ophiocephalus*, Harpodon (Bombay Duck).

Amphibia: *Ichthyophis*, *Necturus*, *Proteus*, *Ambystoma*, Axolotle larva, Salamander, *Siren*, *Alytes*, *Pipa*, *Bufo*, *Hyla*, *Rhacophorus*, *Rana*.

Reptilia: *Testudo*, *Chelone*, *Sphenodon*, *Calotes*, *Hemidactylus*, *Phrynosoma*, *Draco*, *Varanus*, *Chameleon*, *Cobra*, *Hydrophis*, Rattle Snake, Viper, Pit Viper, *Krait*, *Eryx*, *Gavialis*.

Aves: *Archaeopteryx*, Taylor Bird, Indian Koel, Jungle fowl, *Pavo*, *Columba*, *Psittacula*, Wood Pecker, *Bubo* (Horned), Flamingo.

Mammals: *Ornithorhynchus*, *Echidna*, *Macropus*, Hedgehog, *Manis*, *Loris*, Bat, Mongoose, *Hystrix*, Otter.

### 3. Microscopic Slides:

Lower Chordates: *Herdmania* -tadpole larva, *Amphioxus* -T. S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoete- larva whole mount.

Pisces: Placoid scale, Cycloid scale, Ctenoid scale.

Amphibia: V S skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testes, ovary, spinal cord, bone.

Reptilia: V S skin of lizard.

Aves: V S skin of bird, contour feather, down feather.

Mammalian tissues: Blood smear, Simple cuboidal epithelium, Simple columnar epithelium, Simple squamous epithelium, Adipose tissue, Reticular tissue.

Mammals: V S skin of mammals, T S passing through stomach, intestine, liver, pancreas, kidney, testes, ovary, thyroid gland, adrenal gland, pituitary gland, lung, bone, spinal cord.

### 4. Comparative Osteology:

- Comparative account of axial and appendicular skeletons of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
- Skull of Reptiles (Anapsida and Diapsida).
- Palate in Birds.
- Skull and lower jaw of carnivore mammal & herbivore mammal.

### 5. Collection of various types of feathers.

19/1/24  
Dr. R. S. Jaiswal  
Rajasthan  
1924



**Note:**

1. With reference of whole mounts and museum specimens the animal types may be substituted with diagrams/photographs/models etc.
2. It should be ensured that animals used in the practical exercise are not covered under the wild life act 1972 and amendments made subsequently.

**Recommended Books**

1. The Chordata, Alexander, R.M. Cambridge University Press, London.
2. Structure and Habit in vertebrate evolution - carter, G.S.Sedgwick and Jackson, London.
3. Analysis of Vertebrate Structure. Milton Hilderbrand. John Wiley and Sons., Inc, New York.
4. Vertebrate Body. Romer A.S. W.B. Saunders Co., Philadelphia.
5. Life of Vertebrate, Young. J.Z. The Oxford University Press. London.
6. Life of Mammals, Young. J.Z. The Oxford University Press. London.
7. Evolution of the Vertebrates, Colbert. E.H. John, Wiley and Sons Inc., New York.
8. Vertebrate Paleontology. Romer. A.S.University of Chicago Press, Chicago.
9. Chordata Structure and Function. Waterman. A.J.Macmillan Co. New York.
10. Vertebrate Evolution. Joysey.K.A. and T.S.Kemp. Oliver and Boyd. Edinburgh.
11. The Phylogeny of Vertebrate. Lovtrup.S.JohnWiley and Sons. London
12. The Biology of the Amphibia. Kingsley Noble G.Dover Publications. New York
13. Avian Biology (in several volumes), Farner, D. S. and King, J. R., AcademicPress, New York, 1971.
14. Analysis of Vertebrate Structure, Hildebrand, M. 4th edition, John Wiley & Sons, Inc., New York, 1995.
15. Vertebrate Life, McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Macmillan Publishing Co., Inc., New York, 1979.
16. Text Book of Zoology, Parker, T. S. and Haswell, W. A., ELBS, 1978. Weichert CK and Presch. W. Elements of chordate Anatomy 4<sup>th</sup> Ed. Mc Growhall Co. New Delhi.
17. Mammalogy: Adaptation, Diversity, Ecology. 3<sup>rd</sup> Edition, George A Feldhamer Et, Johns Hopkins, 2007.
18. Vertebrates: Comparative Anatomy, Function, Evolution, 7<sup>th</sup> Edition, Kardong, Mc Graw Hill, 2014

**M.Sc. ZOOLOGY III SEMESTER**

**CORE PAPER**

**ZOL C302: GENES AND DIFFERENTIATION**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

**Principles of developmental biology:**

1. Potency, commitment, specification, induction and competence.
2. Determination and differentiation; morphogenetic gradients; cell fate and cell lineages.
3. Development in unicellular eukaryotes and metazoans.

*Pil Jas*

*BOY*

**Early vertebrate development:**

1. Cleavage types
2. Gastrulation, Cell movement and formation of germ layer (fruit fly, frog, chick and mouse)

**Cell- cell interaction and cell signalling:**

1. Cell-cell interaction and cell signalling during morphogenesis in early embryo gastrulation, neurulation and primordial organ rudiments
2. Origin and fate of neural crest cells.

**UNIT-II**

**Body Axes:**

1. Genetics of axis specifications in *Drosophila*
2. Establishment of body axes in mammals and birds
3. Tetrapod limb development
4. Homeobox concept in different phylogenetic groups

**Hormones as mediators of development:**

1. Insect metamorphosis
2. Amphibian metamorphosis

**UNIT-III**

**Environmental regulation and animal development:**

1. Environmental cues and effects
2. Malformations and disruptions.
3. Changing evolution through development modularity
4. Developmental constraints
5. Creating new cell types-basic evolutionary mystery.

**Biology of sex determination:**

1. Chromosomal sex determination in *Drosophila* and Mammals
2. Testis determination genes
3. Ovarian development
4. Secondary sex determination in mammals.
5. Environmental sex determination

**UNIT-IV**

**Embryonic stem cells:**

1. Totipotency and Pluripotency
2. Embryonic stem cells, stem cells niches.
3. Genomic equivalence and the cytoplasmic determinants
4. Renewal by stem cells-epidermis, connective tissue & skeletal muscle

**Hemopoietic Stem cells:**

1. Blood cell formation
2. Bone marrow transplants
3. Stem cell disorders
4. Gene therapy
5. Genetic errors of human development:

**Practicals**

1. To Study life cycle of *Drosophila*
2. Identification of male and female *Drosophila*

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(Academic)  
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Jaipur

3. Identification of wild and mutant forms of *Drosophila*
4. To prepare permanent slide of Sex comb of *Drosophila*
5. To prepare permanent slide of W.M. of *Drosophila*
6. To make a squash preparation of salivary gland chromosome from 3<sup>rd</sup> Instar larva of *Drosophila*
7. Monohybrid and dihybrid inheritance in *Drosophila*
8. Simple problems based on Mendelism
9. Demonstration of sex chromatin
10. Embryology of Frog (slides & preserved materials).
11. Embryology of Chick.
12. Blastoderm mounting of chick embryo
13. To study development of chick embryo through window preparation.

#### Recommended Books

1. Development Biology S.F.Gilbert, Sinauer Associates Inc., Massachusetts
2. Morphogenesis of vertebrate. Torrey, T.W. John Wiley and Sons Inc., New York and London.
3. London.
4. An Introduction to embryology, Balinsky, B.I.: W.B. Saunders Comp., ?
5. Davidson, E.H.: Gene activity in early development. Academic Press, New York.,
6. Modern embryology, Bodemer, C.W.: Holt Chart and Winston, Inc. New York;
7. Chicago
8. Principle of Animal Developmental Biology. Geol, S.C. Himalaya Publishers 1984.
9. Metamorphosis, Etkin, W.L.I. Gilbert.: North-Holland Co., Amsterdam.
10. Developmental Biology. R.M Twyman. Viva Books Private Limited. New Delhi.
11. From egg to Embryo. Slack J.M.W. Cambridge University Press, Cambridge UK.
12. Principles of Development. Wolpert, L. Oxford University Press, Oxford, UK.

### M.Sc. ZOOLOGY III SEMESTER

#### CORE PAPER

#### ZOL C303: EVOLUTION

Max. Marks: 100

Total Hours: 60

#### UNIT I

1. Concept of evolution (Lamarckism, Darwinism & Neo Darwinism).
2. Evidences of evolution (macro and micro) – From comparative anatomy, embryology and physiology.
3. Rate of evolution (Homotely, Bradytely and Tachytely).
4. Time line for major events in the history of life on earth.

#### UNIT II

1. Variations –including transgressive variation.
2. Mutations.
3. Genetic drift.
4. Meiotic drive.
5. Migration.

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6. Natural selection.

### UNIT III

1. Isolation and isolating mechanisms.
2. Species and Speciation – Phylogenetic and biological and other concepts of species, modes of speciation (Allopatric, sympatric, parapatric and peripatric)
3. Adaptation – With special reference to deep sea, desert & aerial.
4. Phenotypic plasticity.
5. Polymorphism

### UNIT IV

1. Punctuated equilibrium and phyletic gradualism.
2. Human evolution.
3. Altruism, selfish gene, coevolution and kin selection.
4. Extinctions and mass extinctions.

#### Practicals

1. Exercises based on natural selection
  - (a) Darwinian fitness
  - (b) Selection coefficient
  - (c) Effects of natural selection on gene frequencies
  - (d) Genetic drift
  - (e) Migration
  - (f) Meiotic drive
2. Construction of phylogenetic trees
3. Study of examples of different types of speciation.
4. Study of examples of adaptations in various habitats.
5. Study of selected stages in human evolution.
6. Study of altruism, co-evolution and kin selection with the help of examples.

#### Recommended Books

1. Encyclopedia of Evolution Vol .I and Vol. II By. Mark Pagel, Oxford University Press
2. Evolution Strickberger, M.W. Jones and Barlantt Publishers, Boston London
3. Evolution and Genetics. J.M. Oxford University Press, New York
4. Evolution and Genetics Merral, D.J. Holt, Rinchart and Winston, Inc.
5. Species Evolution – The role of chromosomal change . King, M. Cambridge University Press, Cambridge.
6. A primer of Population Genetics. Hart, D.L. Suinuaer Associate, Inc. Massachusetts.
7. Evolutionary Biology , Futuyamma, D.J. Suinuaer Associate, Inc. Publishers, Sunder land
8. Genetics and Origin of Species, Dohnzhansky, Th. F.J. Alaya G.L. Stebbines and J.M. Valentine, Surjeet Publication Delhi
9. Genes and Evolution , Jha A.P. John Publication New Delhi

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## ZOL 311: PRACTICAL-V

(Based on ZOL C301, ZOL C302 and ZOL C303)

### Scheme for Practical Examination

Max Marks 100

Time 6 hrs

1. Exercise (Core 1)	16
1. Exercise (Core 2)	16
3 Exercise (Core 3)	16
4. Spotting (8 × 3)	24
5. Seminar	09
6. Viva Voce	10
7. Record	09

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

## M.Sc. ZOOLOGY III SEMESTER

### ZOL 3A01: CANCER & RADIATION BIOLOGY

#### BASICS OF RADIATION BIOLOGY

Max. Marks: 100

Total Hours: 60

#### UNIT-I

##### Fundamentals of radiation:

1. Natural and artificial radioactivity.
2. X-rays production, characteristics and applications, hard and soft X-rays.
3. Ionizing and non-ionizing radiation (electromagnetic radiation).
4. Units of radiation and half-life of radioisotopes.

#### UNIT-II

##### Cellular radiobiology:

1. Effects of radiation on macromolecules.
2. Cell survival curves.
3. Concept of LD50/30 and Dose reduction factor (DRF).
4. Radio-sensitivity of cell cycle phases, cell division delay and cell cycle check points.

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University  
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### UNIT-III

#### Detection monitoring and measurement of radiation:

1. Film badge.
2. Pocket dosimeter.
3. Thermo luminescence dosimeter.
4. G. M. counter.
5. Scintillation counter.
6. Proportional counter.
7. Gamma ray spectrophotometer.

### UNIT-IV

#### Radiation safety and regulatory aspects:

1. Radiation contamination and Decontamination
2. Maximum permissible dose, ALARA
3. Personal management and safe work practice
4. National and International statutory bodies.
5. Radiation accidents and their management

**M.Sc. ZOOLOGY III SEMESTER  
ELECTIVE GROUP A (SPECIAL PAPER)  
ZOL 3A02: CANCER & RADIATION BIOLOGY  
APPLIED RADIOBIOLOGY**

**Max. Marks: 100**

**Total Hours: 60**

### UNIT-I

#### Medical Applications

1. Radiation Imaging
2. Radiation therapy (External beam radiotherapy, Brachytherapy)
3. Radioactive tracers
4. Radioimmunoassay
5. Therapeutic nuclear medicine.
6. Autoradiography.

### UNIT-II

#### Applications of Radiation in communication

1. Radio Frequency (RF) Communication
2. Satellite communication
3. Infrared and Visible Light Communication (Wi-Fi)
4. Cellular Communication (1G to 5G)
5. Bluetooth and Near Field Communication

### UNIT-III

#### Nuclear Energy

1. Introduction to Nuclear Energy

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*12/1/2023*  
*12/1/2023*

2. Nuclear fusion as a potential energy source
3. Nuclear Reactors
4. Nuclear Weapons
5. Safety considerations and containment in nuclear facilities

#### UNIT - IV

##### Application of Radiation in Research and Industry

1. Radiation in Biological Research: X-ray Crystallography, NMR, Circular Dichroism, DLS, XRD
2. Material Science Applications: Industrial radiography, Ion Beam Analysis (IBA): Ion beams, such as Rutherford Backscattering Spectrometry (RBS) and Particle-Induced X-ray Emission (PIXE)
3. Radiocarbon dating

**M.Sc. ZOOLOGY III SEMESTER ·  
ELECTIVE GROUP A (SPECIAL PAPER)  
ZOL 3A03: CANCER & RADIATION BIOLOGY  
RADIATION EFFECTS**

Max. Marks: 100

Total Hours: 60

#### UNIT-I

##### Radiation induced DNA damage and repair:

1. Repair of DNA breaks.
2. Repair of base damage.
3. Photoreactivation, excision repair.
4. Postreplication recovery.
5. Base excision repair, nucleotide excision repair (NER).
6. Transcription coupled repair (TCR) and bulk DNA repair.

#### UNIT-II

##### Radiation Chemistry:

1. Interaction of radiation with matter:
2. Photoelectric and Compton effects.
3. Ion pair production and Scattering.
4. Radiolysis of water.
5. Formation of oxygen reactive species, Oxygen effect.
6. Linear energy transfer and relative biological effectiveness.

#### UNIT-III

##### Cytogenetic effects of radiation:

1. Chromosomal aberrations.
2. Micronuclei induction.
3. Radiation induced Mutations
4. Radiation syndromes

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## UNIT-IV

### Delayed radiation effects:

1. Stochastic and deterministic effects.
2. Direct and indirect effects.
3. Life shortening.
4. Radiation hormesis.
5. Radiologic aging.
6. Radiation carcinogenesis.

### Practicals

1. Symbol of Radiation: Trefoil.
2. Knowledge and use of the various instruments. Geiger-Muller counter.
3. Scintillation counters, Survey meter, Single-channel gamma spectrometer.
4. Cobalt camera. Linear Accelerator.
5. Finding out the operating voltage of the G-M tube.
6. Calculation of Inverse Square Law.
7. Determination of the resolving time of the G-M tube.
8. Absorption of beta and gamma rays.
9. Determination of Back scattering factors.
10. Histopathological, histochemical and biochemical studies of various tissues after external irradiation.
11. Personnel monitoring: use of survey meter, film badge, and room contamination monitor.
12. Decontamination of contaminated material.
13. Visits to the Radiotherapy Department, S.M.S. Medical College, Jaipur; Rajasthan Atomic Power Project, Kota and Bhabha Atomic Research Centre, Mumbai.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

### Recommended Books

1. Radiation Biophysics. Prentice-Hall Engel-Wood Cliffs. Andrews, H. L.: New Jersey. 1974 or Later Edition.
2. Ionizing Radiation and Life. Mosby, Avena, V: St. Louis. 1971 or Later Edition.
3. Low Dose Radiation Biological Bases of Risk Assessment. Baverstock, K. of Staltar, J. Taylor of Francis, 1989.
4. Low level Radiation Effects. Broil. AB. A fact Book: Society of Nuclear Medicine, USA, 1982.
5. Radiobiological Consequences of Nuclear Accidents -Contamination Radioecology, Bulokav EB., V Naiitel and J. B. Reitan: Radiobiology and Health.
6. Radioisotope Methodology. Chase, GD. and Robinowitz, J. L. Burgess Publishing Co. Minneapolis, Minn, USA. 3rd Edition, 1967 or Later.
7. Biological Effects of Radiation. Coggle. J.E.: Taylor and francis Ltd., London, 1988 or Later Edition.
8. Medical Radiation Biology. Dalrymple, G. V, Ganldev, M.E., Kollmorgen, G. M. and Vogel, H. J. Saunders. Philadelphia, 1973 or Later Edition.
9. Introductory Biostatistics for the Health Sciences. Duncan R. C., Knapp., R. G., and Miller III, M.C., :John Wiley and Sons. Inc., New York, 1977 or Later Edition.

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10. Radiobiology. Fobrikant. J. I.: Year book med., Chicago, 1972 or Later Edition.
11. Biological Assessment of occupational Exposure to Actinides. G. B. Gendes, H. Metives and J. Stathes: Nuclear Tech. Pub. Kent, 1989.
12. Environment and Human Risks of Tritium, Gesben, G., C. M. Menaene and H. Smilts: Nuclear Tech. Pub. Kent, 1986.
13. Applied Radiobiology of Radiation Protection. Granien, R., Prentice Hall, 1990.
14. Biological Effects of Radiations. Grosel, D. S. and Hop Zwood, L.E. Academic Press, New York, 2nd Edition, 1979 or Later Edition.
15. Radiobiology for the Radiologist. 3rd Edition, Hall. E. L.: Harper and Row, 1990 or Later Edition.
16. Radiation and Life. Hall. E. I.: Pergamon Press, Oxford, U. K. 2nd Edition, 1987.
17. Health Effects of Low Level Radiation, Hendec. w. R.: Prentice Hall. 1984.
18. Low level Radiation and Living State. Huilgol. N. G. et al.: Naraza Publishing House, Community Center Panchsheel Park, New Delhi, 1993.
19. Biological Radiation effects. Kiefer, J. Springer-Venlag, Berlin, 1989.
20. Developmental Effects of Prenatal Irradiation. Kriegel, H..VCH,. 1982.
21. Cellular Radiobiology. Lawrence c.w. Arnold, London, 1971 or Later Edition.
22. Biological Aspects of Human Irradiation Eds. Pant, G. S., and Basu, AK. Himalaya Publishing House, Delhi, 1992.
23. Basic Radiation Biology. Pizzarello D.J., Witcofsli Lea R. L. and Febiger: Philadelphia, 1970 or Later.
24. Human Radiation Biology. Prasad, K. N., CRC Press, inc. Cleveland, Ohio, USA, 1984.
25. Advanced Medical Radiation Dosimetry. Rajan O. Prentice-Hall of India Pvt. Ltd. New Delhi, 1992.
26. Frontiers of Radiation Biology. Riklin, E. ed. VCH, 1990.
27. Radiation Exposure and Occupational Risks. Scheres, E., c. Streffer, K. R. Trott.: Eds. Berlin, 1990.
28. Elements of Radiobiology, Seiwan J. Thomas, C. C. 1983.
29. Essential of Radiation Biology and Protection, Steve Forshie: Publisher: Delmar Cengage Learning.
30. Radiation Carcinogenesis. Upton, A. C. Ehseviees, 1986.

**ZOL 312: PRACTICAL-VI**  
**Scheme for Practical Examination**  
**(Based on ZOL 3A01, ZOL 3A02 and ZOL 3A03)**

Max Marks: 100	Time 6 hrs.
1. Exercise 1	20
2. Exercise 2	16
3 Exercise 3	10
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

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 Dr. Ramesh Chandra  
 (Head of the Department)  
 University of Rajasthan  
 JAIPUR  
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**M.Sc. ZOOLOGY III SEMESTER**  
**ELECTIVE GROUP B (SPECIAL PAPER)**  
**ZOL 3 B01: CELL AND MOLECULAR BIOLOGY**  
**CELLULAR STRUCTURE AND FUNCTION**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Biomembranes:**

1. Molecular constituents of membranes: Lipids (glycerophospholipids, sphingophospholipids, glycolipids, sterols); proteins (extrinsic, intrinsic –glycophorin, porin & fusion proteins)
2. Fluid Mosaic model.
3. Fluidity and mobility of lipids and proteins.
4. Diseases: Tay Sachs disease & Nieman –Picks disease.
5. Chemistry of fixatives: Common properties of fixatives, formalin, acetic acid, alcohol acetone, picric acid, gluteraldehyde, metallic ions and complexes.
6. Choice of fixatives: Glycogen, lipids, nucleic acid, enzymes (alkaline phosphatase, acid phosphatase, esterase & sulphatase).

**UNIT-II**

**Transport across cell membrane:**

1. Mechanism of diffusion; Facilitated diffusion.
2. Osmosis, permeability constant, factors influencing permeability & Gibb's – Donnan effect.
3. Uniporter-catalyzed transport, difference between uniport-catalyzed transport and passive diffusion, GLUT- 1-5 transport & its kinetics.
4. Ion channels and membrane electric potential (Nernst equation).
5. Active transport - P-class ion pumps, F-class and V-class ion pumps, ABC superfamily. Plasma membrane  $Ca^{++}$ AT Pase pump, Muscle  $Ca^{++}$ ATPase pump &  $Na^+/K^+$  ATPase pump, Ionophores.
6. Cotransport by symporters and antiporters.
7. Transport across epithelia; Endocytosis: pinocytosis, phagocytosis & receptor mediated; Transcytosis.
8. Diseases: Cystic fibrosis & Type I *Diabetes mellitus*.

**UNIT-III**

**Cytoskeleton:**

1. Intermediate filament: Proteins, assembly, organization (desmosomes, hemidesmosomes, desmin & neurofilaments).
2. Microfilaments:
  - (i) Actin: G-actin, F-actin, structural and functional polarity.
  - (ii) Assembly, disassembly and organisation of actin filaments: Polymerization, actin –binding proteins (Formin, Arp2/3 complex, ADF/ Cofilin, Profilin, CapZ etc.), actin bundling proteins, toxins affecting polymerization.
3. Actin filaments and plasma membrane: RBC cytoskeleton, platelet cytoskeleton & projecting fingers of membrane.

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4. Myosin: Structure, mechanism of movements with actin & conformational changes in myosin during movement.
5. Microtubules: Structure, assembly of microtubules from organizing centre, dynamic organization, microtubule associated proteins (MAPs), microtubules associated structures (Centrosome duplication, kinetochore and force for poleward chromosome movement, Organization of spindle pole and orientation of assembly, astral microtubule and cytokinesis & microtubules and plant cell formation) and drugs disrupting microtubules.
6. Microtubules motor proteins:
  - (i) Intracellular transport: Role of kinesin and dynein, microtubule tracks and intracellular membrane vesicles.
  - (ii) Amoeboid movements.

**Cilia and flagella:**

1. Structure and movements
2. Syndrome /disease –Kartagener’s syndrome & Charcot-Marie-Tooth disease.

**UNIT-IV**

**Cell-cell adhesion and communication:**

1. Cadherin mediated  $Ca^{2+}$  dependent homophilic cell-cell adhesion.
2. N-CAM's mediate  $Ca^{2+}$  independent homophilic cell-cell adhesion.
3. Cell junctions: Occluding junctions, anchoring junctions (adhesion belts, focal contacts, desmosomes & hemidesmosomes) & communicating junctions (gap junctions, chemical synapses & plasmodesmata).
4. Cell adhesion molecules as diagnostic tools in cancer.

**Cell matrix adhesion molecules:**

1. Integrin-in cell matrix and cell-cell interaction.
2. Collagen-Basic structure and assembly.
3. Non-collagen components of extracellular matrix (elastin, glycosaminoglycan, cell
4. Surface proteoglycans, fibronectin & laminin).
5. Role of selectin, integrin & Ig in extravasation.

**Cell wall:**

1. Bacterial cell wall.
2. Plant cell wall.

**M.Sc. ZOOLOGY III SEMESTER**

**ELECTIVE GROUP B (SPECIAL PAPER)**

**ZOL 3 B02: CELL AND MOLECULAR BIOLOGY**

**CELLULAR PHYSIOLOGY AND REGULATORY MECHANISM**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Cell-Cell signalling:**

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1. Endocrine, paracrine and autocrine signaling.
2. Receptor Proteins: Cell surface receptors and intracellular receptors, toll receptors.
3. Second messenger System: cAMP & signal to transcription (CREB); IP<sub>3</sub> DAG and PIP<sub>3</sub> (PI-3 kinase, AKT & mTOR pathway).
4. Cell Surface receptors: G-protein coupled receptors (hormones etc.), ion channel receptors (voltage gated channel, ligand gated channel & signal gated channel), tyrosine kinase-linked receptors (general idea, EGF, erythropoietin & interferon) and receptors with intrinsic enzymatic activity.
5. MAP kinase, JAK/STAT and TGF- $\beta$  / Smad signaling and NF-kB signaling.

#### Signal-mediated transport through nuclear pore:

1. Nuclear pore complex.
2. Nuclear exports signals and transport of cargo proteins from nucleus to cytosol.
3. Nuclear localization signal and transport of cargo proteins from cytoplasm to nucleus.

#### UNIT-II

##### Cell cycle:

1. Bacterial cell cycle (Helmstetter –Cooper or I+ C+ D model);.
2. Eukaryotic cell cycle
3. Cell cycle check points
4. Cell cycle regulation

#### UNIT-III

##### Cell death (Apoptosis):

1. Apoptosis and necrosis
2. Caspases: Initiator, executioner & inflammatory
3. Bcl<sub>2</sub> family proteins: antiapoptotic, apoptotic & derepressors.
4. Extrinsic death receptor pathway (TNF-1 & Fas); intrinsic mitochondrial pathway & mitophagy
5. Inhibitors of apoptotic proteins
6. Caspase independent cell death

#### UNIT-IV

##### Aging: The biology of senescence

1. Cellular basis of aging
2. Free radicals, oxidative damage and antioxidants.
3. Telomerases and aging.
4. Diseases: Alzheimer's, Parkinson's, Type II diabetes & Progeria .

### M.Sc. ZOOLOGY III SEMESTER

#### ELECTIVE GROUP B (SPECIAL PAPER)

#### ZOL 3B03: CELL AND MOLECULAR BIOLOGY

#### GENE EXPRESSION

Max. Marks: 100

Total Hours: 60

#### UNIT-I

##### Molecular structure of genes and chromosomes:

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 (Academic)  
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1. Molecular definition of gene (recon, muton & cistron –complementation test).
2. Chromosomal organization of genes and non-coding DNA.
3. Functional re-arrangements in chromosomal DNA.
4. Morphological and functional elements of eukaryotic chromosomes.
5. Transposons: Retrotransposons – viral & non viral (LTR, reverse transcription of retroviral genomic RNA to DNA); Transposons; Miniature inverted Repeats transposable elements & transposons in bacteria.

#### Genes:

1. Mutable units: Seymour Benzer experiment-complementation test.
2. Mutation:Types and causes (radiation, chemical & environment).
3. Mutation rates;Reversion & suppression.
4. Isolation (Positive & negative selection) and analysis of mutants.

### UNIT-II

#### Regulation of gene expression:

1. Operon concept.
2. Inducers and corepressors.
3. Positive and Negative regulation – *lac* operon.
4. Regulation by attenuation: *trp* operon.

#### Lytic and lysogeny:

1. Lambda lytic cascade
2. Lysogenic repression

### UNIT-III

#### DNA binding proteins and gene regulation:

1. Homeodomain proteins.
2. Zinc finger proteins.
3. Winged-helix (Forked head) proteins.
4. Leucine-Zipper proteins.
5. Basic Helix - Loop - helix proteins.
6. Helix- turn –Helix.

### UNIT-IV

#### Cancer:

1. Tumor types: Benign & malignant; sarcoma & carcinoma and leukaemia &lymphoma.
2. Onset of cancer; Metastasis.
3. Properties of cancer cells.
4. Knudson two hit hypothesis
5. Proto-oncogene; retroviral oncogenes; oncogenes; tumor suppressor genes (RB, p53) and caretaker genes (BRCA1 & BRCA2).

#### Practicals

1. Paraffin blocks preparation of mammalian tissue for microtomy.
2. Sectioning and processing by Haematoxylin and Eosin staining.

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3. Study of cells/ tissues using fluorescence microscope.
4. Standardization of ocular micrometer.
5. Use of stage and ocular micrometer for measuring cell dimensions.
6. Histochemistry: Carbohydrate - PAS method
7. Histochemistry: Proteins -Ninhydrin method.
8. Detection of enzymes (a) Alkaline phosphatase (b) Acid phosphatase.
9. Tissue homogenization and fractionation.
10. Comet assay.
11. Agarose gel electrophoresis of mammalian DNA
12. Electroelution of DNA from electrophoretic gels.
13. Separation of proteins using SDS-PAGE.
14. Isoenzymes study using PAGE
15. Study of permanent slides :Mitosis, Meiosis, types of cancer cells

**Note:** It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

#### Recommended Books

1. The Biochemistry of the Nucleic Acids. Adams RLP, Knowler JT and Leader DP. Chapman and Hall, London. 1986.
2. Essential Cell Biology 4<sup>th</sup> edition. Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K and Walters P. Garland Science Publishing New York UISA ,2013.
3. Molecular Biology of the Cell. 5<sup>th</sup> edition. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P. Garland Science. 2007.
4. Molecular Biology of the Cell. 4<sup>th</sup> edition Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Garland Science .2002.
5. From Genes to Cells. Bolrover SR, Hyams JS, Jones S, Shephard EA and White HA. Wiley -Liss, New York. 1997.
6. A Means to an End: The Biological Basis of Aging and Death. Clark WR. Oxford University Press, New York, Oxford. 2002.
7. The Cell .A Molecular Approach. 4<sup>th</sup> edition. Cooper GM and Hausman RE. ASM Press Washington, DC. 2007.
8. Cell Adhesion and Cytoskeletal Molecules in Metastasis. Cross AE and Nagle RB. Vol XII. Springer Publications 2006.
9. Molecular Cell Biology. 5<sup>th</sup> edition W Darnell J. H Freeman and Company, New York, 2004.
10. Cell and Molecular Biology. 8<sup>th</sup> edition. De Robertis EDP and De Robertis Jr EMF Lippincot Williams & Wilkins 2006.
11. Cell Adhesion Molecules in Cancer and Inflammation. Epenetos A and Pignatelli M. Harwood Academic Publishers, CRC Press 1995.
12. Cancer Stem Cells. Farrar WL. Cambridge University Press. 2009.

13. DNA Repair and Mutagenesis. Friedberg EC, Walker GC and Siede W. ASM Press, Washington DC 1995.
14. BRS Cell Biology and Histology. 6<sup>th</sup> edition (South Asian Edition), Gartener LP, Hiatt JL, Strum JM. Lippincott Williams & Wilkins, 2010.
15. Molecular biotechnology. Principles and Applications of Recombinant DNA. Glick BR and Pasternak JJ. ASM Press Washington DC, 1998.
16. Cell and Molecular Biology. Concepts and Experiments. 7<sup>th</sup> edition. Karp G. John Wiley & Sons Inc., New York. 2013.
17. Cell Biology. 6<sup>th</sup> edition. Karp G. Hoboken, NJ: Wiley 2013.
18. Essential Genes. Levin B Pearson Higher Education .International edition. 2006.
19. Genes IV. Lewin B. Oxford University Press Bombay, 1990.
20. Genes V. International Students Edition. Lewin B. Oxford University Press Oxford, 1994.
21. Genes VII. Lewin B. Oxford University Press, Oxford, 2000.
22. Genes VIII. Lewin B. Pearson Education International .London, Sydney. 2004.
23. Molecular Cell Biology 6<sup>th</sup> edition. Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, Matsudaira P. W.H Freeman and Company, New York, 2008.
24. Molecular cell Biology. 5<sup>th</sup> edition. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Scott MP, Zipursky SL, Darnell J W.H Freeman and Company, New York 2004.
25. Molecular Cell Biology. 4<sup>th</sup> Edition Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D, Darnell J. W.H Freeman and Company, New York, 2000.
26. Molecular Cell Biology. 7<sup>th</sup> edition. Lodish H, Berk A, Kaiser CA, Krieger M, Bertscher A, Ploegh H, Amon A, Scott M P. Mac Millian High Education (International edition) England 2013.
27. Lewin's Cell. 2<sup>nd</sup> edition. Lynne C, Lingappa VR and Plopper G (Editors). Jones & Bartlett Publishers, USA 2011.
28. Essentials of Molecular Biology. Malacinski GM and Friefelder D. Jones and Bartlett Publishers, Boston 1999.
29. Molecular Biology and Biotechnology. Meyers R.A. A Comprehensive Desk Reference. VCH Publishers. 1995.
30. Advancements in Cancer Stem Cell Biology. Scantena R, Mordente A, Giardina B. Springer Publication 2012.
31. Genetics and Molecular Biology. 2<sup>nd</sup> edition. The John Hopkins university Press. Schleif R. Baltimore & London. 1993.
32. Stem Cell Therapeutics for Cancer. Shah Khalid. John Wiley & Sons Inc. Hoboken, New Jersey. 2013.
33. Cell and Molecular Biology. Shelve P and Blanch DEW. John Wiley & Sons Inc., New York. 1994.
34. Genes to Proteins 3<sup>rd</sup> edition. Molecular Biology. Tropp B E. Jones & Bartlett Publishers, Sudbury Massachusetts. 2008.
35. Advanced Molecular Biology. A Concise Reference . Twyman RM and Wisden W. Viva Books Pvt Ltd. New Delhi 1999.
36. Molecular Biology of the Gene. 7<sup>th</sup> edition. Watson J, Baker T, Bell S, Gann A, Levine M and Losick R Pearson Higher Education 2013.
37. Molecular Biology of the Gene. 5<sup>th</sup> edition Watson J, Baker T, Bell S, Gann A, Levine M and Losick R. Pearson Higher Education 2008.
38. Recombinant DNA 2<sup>nd</sup> edition. Watson JD, Gilman M, Witkowski J and Zoller M. W.H Freeman and Company, New York 1992

39. Molecular Biology. 2nd edition. Weaver R.F. McGraw Hill Company, New York, NY 2002.
40. Molecular Biology, 3rd edition, Weaver, R.F., McGraw-Hill Company, New York, NY 2005,

### ZOL 312B: PRACTICAL-VI

Scheme for Practical Examination  
(Based on ZOL 3B01, ZOL 3B02 and ZOL 3B03)

**Max Marks: 100**

**Time: 6 hrs**

1. Exercise 1	20
2. Exercise 2	16
3. Exercise 3	10
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

**Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.**

### M. SC ZOOLOGY III SEMESTER

#### ELECTIVE GROUP C (SPECIAL PAPER)

#### ZOL 3C01: ENTOMOLOGY

#### PHYLOGENY, TAXONOMY AND EVOLUTION OF INSECTS

**Max. Marks: 100**

**Total Hours: 60**

#### UNIT-I

1. Collection, preservation and methods of study of insects.
2. Historical development of classification of insect, basis of insect classification.
3. Use of taxonomic keys in insect identification.
4. Elementary idea of DNA base reading and its application in insect identification.

#### UNIT-II

1. Origin and evolution of insects, theories of evolution of insects, fossil history.
2. Causes of success of insects, evolution of flight and socialism.
3. Phylogeny of Arthropoda and Hexapoda.
4. Introduction to primitive insects:
  - a) Protura,
  - b) Collembola
  - c) Diplura.

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- d) Microcoryphia
- e) Thysanura.

### UNIT-III

Detailed classification of orders up to families (economically important):

- 1. Orthoptera
- 2. Isoptera
- 3. Hemiptera
- 4. Phasmida
- 5. Dictyoptera
- 6. Dermaptera

### UNIT-IV

Detailed classification of orders up to families (economically important):

- 1. Odonata
- 2. Thysanoptera
- 3. Coleoptera
- 4. Lepidoptera
- 5. Diptera
- 6. Hymenoptera

## M. SC ZOOLOGY III SEMESTER

### ELECTIVE GROUP C (SPECIAL PAPER)

### ZOL 3C02: ENTOMOLOGY

### MORPHOLOGY AND PHYSIOLOGY OF INSECTS

Max.

Marks:

100

Total Hours: 60

### UNIT-I

- 1. Integument: structure and function, moulting and mechanism of cuticular sclerotization.
- 2. Head: Sutures and area of cranium, Dyar's law, tentorium, gnathalappendages, antennae.
- 3. Thorax: legs and their modifications, wings and wing coupling, wing bearing segment.
- 4. Abdomen: male and female external genitalia and their modifications, abdominal appendages.

### UNIT-II

- 1. Digestive system: Alimentary canal and its modifications (including filter chamber), physiology of digestion.

2. Physiology of circulatory system.
3. Excretory system and its modification (cryptonephridial system)
4. Respiratory system and its modifications, adaptations for aquatic respiration.

#### UNIT-III

1. Nervous system and its modifications.
2. Sense organs: mechanoreceptors, Chemoreceptors.
3. Auditory organs (tympanum), light producing organs, sound producing organs, visual organs (Compound eye and ocelli).

#### UNIT-IV

1. Muscular system and distribution of muscles.
2. Reproductive system. Morphology and physiology of male and female reproductive system, its associated ducts and glands and pheromones.
3. Insect behaviour: mating, feeding and defensive strategies (defensive organs and their products: allomones, kairomones and pheromones, blood as defensive secretion, adaptations to autointoxication).

### M. SC ZOOLOGY III SEMESTER

#### ELECTIVE GROUP C (SPECIAL PAPER)

#### ZOL 3C03: ENTOMOLOGY

#### DEVELOPMENT AND ECOLOGY OF INSECTS

Max. Marks: 100

Total Hours: 60

#### UNIT-I

1. Embryology: Structure of eggs, types, embryonic and postembryonic development, parthenogenesis.
2. Morphology and physiology of neuroendocrine system.
3. Metamorphosis and endocrine control of development and metamorphosis.
4. Types of larvae and pupae.

#### UNIT-II

1. Social life in Isoptera
2. Social life in Hymenoptera.
3. Life cycle of locusts (phase theory)
4. Life cycle of aphids (polymorphism).

#### UNIT-III

1. Effect of physical factors, viz., temperature, light, relative humidity, wind, etc. on insects.

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2. Intraspecific interactions of biotic factors.
3. Interspecific interactions of biotic factors.
4. Insect plant interaction: theory of co-evolution, role of allelochemicals in host plant mediation, tritrophic interaction, host plant selection by phytophagous insects, establishment of insect population on a plant surface.

#### UNIT-IV

1. Population ecology: population dynamics, size, fluctuation, biogeography, factors affecting population density, methods of determination of population density of insects.
2. Community ecology, community structure and diversity.
3. Biochemical adaptations to environmental stress: diapauses, polymorphism, swarms, outbreaks and migration.
4. Biodiversity: Definition, types and methods of study, species diversity indices- species richness, simpson's index, Shannon-Weiner Index, and Pileou's Evenness Index.

#### PRACTICALS

1. ANATOMY:
  - a. Cockroach: Alimentary canal, Nervous system, Neuroendocrine complex.
  - b. Grass hopper/ *Chrotogonus*: Alimentary canal, Reproductive system, Nervous system.
  - c. *Gryllus*: Nervous system.
2. Permanent Mounting
  - a. Types of mouth parts
  - b. Types of antennae
  - c. Types of legs
  - d. Types of wings
  - e. Tympanum, spiracle and trachea
3. Study of prepared slides
  - a. Whole mounts of insects
  - b. Legs
  - c. Mouth parts
  - d. Wings
  - e. Antennae
  - f. Histology of insects
4. Study of selected insects
  - a. Collection and preservation of Orthopteran, Dictyopteran, Dermapteran, Hemipteran, Phasmida etc., insects
  - b. Study of selected insects and their identification with the help of taxonomic keys.

5. Exercise in Physiology and Biochemistry
  - a. Analysis of honey and its quality control.
  - b. Analysis of chitin presence in the insect integument.
  - c. Study of pH of the gut in larvae of insects
  - d. Action of amylase enzyme in the cockroach.
  - e. Application of Dyar's law.
  - f. Study of polytene chromosome.
  - g. Detection of Allantoin in cockroach excreta by paper chromatography.
  - h. Haemocyte count.
  - i. Biochemical estimation of haemolymph.
6. Microtomy
7. Field trips for biodiversity study and insect collection.

#### Recommended Books

1. Agricultural Pests of India & South east Asia, Atwal: Kalyani Publishers.1986
2. The Insects: Structure & function 4<sup>th</sup> ed. Chapman: ELBS,1998
3. Physiological System in insects, Klowden: 2002
4. Essential Entomology, Oxbord Uni. McGavin: 2001
5. Principles of Insect Morphology Snodgrass:
6. The Principles of Insect Physiology Wigglesworth-
7. Borror and DeLong's introduction of the study of insects –Charles A, Triplehorn and Norman F., Johson, Thomson Books/Cole
8. Insect Physiology and Biochemistry, Third Edition, James L Nation Sr, T&F, 2016
9. Insect Ecology, Nitish Shekhar, Sonali Publications, 2012
10. Practicals in Basic Entomology, Sathe, TV Bhoje, PM Kolekar, Vaishali S., Daya Publishing House, 2014.

#### ZOL 312C: PRACTICAL-VI

##### Scheme for Practical Examination (Based on ZOL 3C01, ZOL 3C02 and ZOL 3C03)

Max Marks: 100

Time: 6 hrs

1. Exercise 1	20
2. Exercise 2	16
3. Exercise 3	10
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

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Note :

1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of charts/models/CD- ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.
2. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

**M.Sc. ZOOLOGY III SEMESTER**

**ELECTIVE GROUP D (SPECIAL PAPER)**

**ZOL 3 D01: ENVIRONMENTAL BIOLOGY**

**ENVIRONMENTAL BIOLOGY: CONCEPT AND APPROACHES**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Introduction to environmental biology and earth systems:**

1. Definition, principle and scope of environmental biology, its relation to other Sciences.
2. Basic concept of ecosystem, abiotic and biotic factors, structure and function of ecosystem, productivity, trophic levels, ecological pyramids and energy flow in an ecosystem.
3. The origin and structure of earth, primary differentiation and formation of core, mantle, crust.
4. Geomorphological processes-plate tectonics, sea floor spreading, mountain building, evolution of continents and structural deformation.
5. Major biomes of the world, Ecozones of India, Anthropogenic biomes.

**UNIT-II**

**The physical environment:**

1. Lithosphere - Weathering and soil formation, - soil colloids, adsorption and exchange of anions and cations, role of microbes in soil, types of soil, soil profile, classification of rocks, folds, faults and dykes and other geological formations and their environmental significance.
2. Atmosphere -Physico-chemical characteristics and divisions- Troposphere, Stratosphere, Mesosphere, Thermosphere & Magnetosphere, composition and significance of atmospheric components.
3. Hydrosphere -Visible and invisible hydrosphere, Range of aquatic habitats, water cycles between earth and the atmosphere, Global water balance, ice sheets, origin and composition of sea water, sea level changes, River basins and watershed.
4. Physico-chemical characteristics of water, Influence of pH, turbidity and light on aquatic life.

### UNIT-III

#### Weather and climate:

1. Definitions and scope of climatology, weather and climate, components of climate system, Climatic regions of India.
2. Earth's thermal environment, earth intercepts solar radiation, seasonal variation in intercepted solar radiation, air temperature in relation to altitude.
3. Global circulation of air masses, wind and earth's rotation on ocean currents, influence of temperature on moisture content of air, global pattern of precipitation, influence of topography on regional pattern of precipitation.
4. Classification of climate-Koepfen's classification and Thorn Thwaite's scheme, Climatic zones, Clouds and their types.
5. Causes of climate change. Effect of climate change on ecosystems, organisms and human welfare.

### UNIT-IV

#### Landscape ecology:

1. Land and Landscape processes; ecological principles at work with Landscapes.
2. Land use in agro-ecosystems, urban ecosystems, rangelands, riparian and wetland systems (Keoladeo, Sambhar Lake and Sunderbans), coastal and estuarine systems (Chilka Lake, Kerala Backwaters and Ennore Creek).
3. Ecological land degradation, desertification, water logging, salinization and soil erosion.
4. Ecological assessment of landscape for vegetation and habitat. Land suitability analysis and carrying capacity studies.

### M.Sc. ZOOLOGY III SEMESTER

#### ELECTIVE GROUP D (SPECIAL PAPER)

#### ZOL 3 D02: ENVIRONMENTAL BIOLOGY

#### POPULATION ECOLOGY, ENVIRONMENTAL ADAPTATIONS AND ENVIRONMENTAL DISASTERS

Max. Marks: 100

Total Hours: 60

### UNIT-I

#### Population ecology:

1. Population and its characteristics.
2. Demography- Life tables, generation time, reproductive value, Census and sampling, Population indices
3. Population growth: Growth of organisms with non-overlapping generations, stochastic and time lag models of population growth, stable age distribution.

4. Population regulation: Extrinsic and intrinsic mechanisms, population density, population dispersal.
5. Methods of population estimation- Point and line survey methods, Belt and Quadrate transect.

#### UNIT-II

##### **Environmental adaptations:**

1. Kinds of Adaptations, Aquatic adaptations, Secondary aquatic adaptations, Pelagic adaptations, Deep sea adaptations. Eco-physiological adaptations to fresh water and marine environments.
2. Terrestrial adaptations- Desert adaptations, Cave adaptations, Cursorial adaptations, Fossorial and subterranean adaptations, Arboreal adaptations, Flight adaptations.
3. Eco-physiological adaptations to terrestrial environments.
4. Parasitic adaptations, adaptations for defense and mimicry.

#### UNIT-III

##### **Environmental limiting factors:**

1. Law of minimum, Law of Tolerance, Environmental limiting factors.
2. Physical environment as limiting factor- Light, humidity, fire, atmospheric gases, current and pressure.
3. Inter and intra-specific relationships: Predator- prey relationship, predator dynamics, optimal foraging theory (patch choice, diet choice, prey selectivity, foraging time). Parasitism, Mutualism, Phoresis, Antibiosis, Insect-plant interactions.

#### UNIT-IV

##### **Environmental phenomena and disasters:**

1. Definition, Earthquake, flood, Tsunami, draught.
2. Windstorms, Cyclones and anticyclones.
3. Volcanoes, Avalanche, lightening, El Nino and La Nina
4. Environmental degradation by anthropogenic activities: Ozone depletion and Green house effect. Nuclear disasters: Fukushima Daiichi nuclear disaster, Japan; Chernobyl disaster, Russia; Bhopal Gas Tragedy, Exxon Valdez Oil Spill.
5. Disaster management.

**M.Sc. ZOOLOGY III SEMESTER**

**ELECTIVE GROUP D (SPECIAL PAPER)**

**ZOL 3 D03: ENVIRONMENTAL BIOLOGY**

**NATURAL RESOURCES, BIODIVERSITY, WILDLIFE AND  
CONSERVATION BIOLOGY**

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2023-24

Max. Marks: 100

Total Hours: 60

### UNIT-I

#### Natural resources:

1. Natural resources and their types- Water resources, Land resources and Biological resources, Mineral resources and their cycles.
2. Energy resources- Renewable sources of energy, energy from biomass
3. Non-renewable sources of energy, Nuclear energy, geothermal energy.
4. Energy for the future, Forest resource.
5. Water- A vital resource, India's Water budget.
6. Human impact on natural resources.

### UNIT-II

#### Biodiversity:

1. Concept of biological diversity, origin of biodiversity, types of biodiversity, values of biodiversity, loss of biodiversity.
2. Biodiversity and ecosystem function, Bio-wealth, Bioprospecting and Biopiracy.
3. Critically endangered Indian animals, Biotic impoverishment
4. Biotechnology and biodiversity, Biotechnology and Intellectual Property Rights (IPR).
5. Indian Biodiversity Act 2002, National Biodiversity Authority, National Board of Biodiversity, State Board of Biodiversity. People's Biodiversity Register (PBR). Biodiversity Management Committee (BMC)

### UNIT-III

#### Wildlife and its management:

1. Wild life schedules, National parks, Sanctuaries, Reserves. IUCN classification of endangered species, Red data book. Threatened animals of India.
2. Restoration of wild life population: Re-introduction or Rehabilitation (soft and hard release) and captive breeding, wild life corridor.
3. Techniques of studying wild life: Radiometry, Photographic and Pug mark identification of animals.
4. Management: Special Protection Programmes- Tiger, Rhino, Lion, Macaque, Elephant, Crocodile and Great Indian Bustard.

### UNIT-IV

#### Biodiversity conservation:

1. Strategies for biodiversity conservation- *In-situ* conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. *Ex-situ* conservation: botanical gardens, zoos, aquaria, homestead gardens, herbaria, *In-vitro* conservation: germplasm and gene bank; tissue culture: pollen and spore bank, DNA bank. Global Environment Facility-World Bank initiatives. Biodiversity hotspots and hope spots and their characteristics.



2. National and international programmes for biodiversity conservation. CITES and TRAFFIC.
3. Traditional conservation strategies; People's participation in Conservation-Participatory Forest Management (PFM), Community reserve and Milestones of biodiversity conventions.
4. Wildlife values and eco-tourism, wildlife distribution in India, problems in wildlife protection-Policies and programmes.

#### Practicals

1. Mark location of different biomes on world map and write their characteristics.
2. Mark important Sanctuaries and National Parks of Rajasthan on map and write details of any two.
3. Mark major Ecozones of India on map of India. Visit a desert/grass land /rain forest and submit write up.
4. Soil texture using micrometry from two different sites.
5. Determination of moisture content of soil.
6. Determination of soil pH from at least three different locations and correlate it with the soil type.
7. Analysis of soil composition: Chloride, Calcium, Magnesium, Potassium and Phosphorous.
8. Estimation of sulphates in soil.
9. Estimation of fluoride in soil.
10. Measurement of water quality based on Acidity, Alkalinity, Dissolved oxygen and Free CO<sub>2</sub> in water sample.
11. Study the abiotic components i.e. pH, turbidity, temperature and light intensity of water in a pond ecosystem.
12. To study the biotic components of pond ecosystem.
13. Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results.
14. Compare the results of Dark and Light bottle method and Chlorophyll method.
15. Identification of trophic levels from gut analysis (Fish or insect).
16. Study the ecology of Aravali Hill around the Arboretum in Jaipur.
17. Find out density of Gerbils/ Fish by Mark and recapture method (Lincoln index).
18. Find out density of Monkeys/any domestic animal in an area using Line transect method.
19. Study the local plant species around your residence/University campus.
20. Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, evenness and diversity indices. (This can be done as part of the three / four day field study compulsory for this elective).
21. Visit to Institutions engaged in environment /conservation research; a sanctuary/national park. Report the study conducted and submit a write up/ print out giving the dates, methodology, results and references. Include photographs of the activity.

### Recommended Books

1. The Atmosphere. Lutgens, F.K. and Tarbuek, J.E. 1992. Prentice Hall, New Jersey
2. Ecology, Individuals, Populations and Communities. Begon, M., J.I., Harper and C. R. Townsend. Science. Oxford.
3. Ecological Concepts. Cherrett, J. M. Blackwell Sci. Publications. Oxford U. K.
4. Population Biology. Elseth. B. D. and K. M. Baumgartner. Van Nostrand Co., New York.
5. Fundamentals of ecological modeling. Jorgensen, S. E., & Bendoricchio, G. (Vol. 21). Elsevier.
6. Ecological Census Techniques-A Handbook (2<sup>nd</sup> Edition). William J. Sutherland. Edited by William J. Sutherland.
7. Ecological Methods. IV<sup>th</sup> Edition, Southwood, T. R. E., Dr. Peter A. Henderson. Wiley-Blackwell.
8. Ecological Methodology. II<sup>nd</sup> Edition Charles J. Krebs.
9. Edward J. Concepts of Ecology. (4 Ed.). Kormondy.
10. Freshwater Ecology: Principles and Applications. Michael Jeffries and Derek Mills. John Wiley.
11. Fundamentals of Ecology. Odum E.P. and Barrett, G. W. (2005). Thomson Asia Pvt. Ltd. Singapore.
12. Climate change: past, present and future. Mathur, U. B. Geological Society of Bangalore 2010.
13. Coastal Ecosystem Processes. Alongi, D. M. 1998. CRC Press, New York.
14. Ecology: Principles and Applications. Chapman, J.L. and Reiss, M.J. 2005. Cambridge University Press, London.
15. Land Mosaics: The Ecology of Landscapes and Regions. Forman, R.T. 1995. Cambridge Univ. Press, Cambridge, UK.
16. Landscape Ecology. Forman, R.T.T. and Godron, M. 1986. John Wiley & Sons, New York.
17. Ecology: The Experimental Analysis of Distribution and Abundance. (6<sup>th</sup> edn.). Krebs, C.J. 2008. Benjamin Cummings Publ., USA.
18. An Advanced Textbook on Biodiversity: Principles and practice. Krishnamurthy, K.V. 2004. Oxford and IBH. Publ. Co. New Delhi.
19. Encyclopedia of Biodiversity. Levin, S. A. 2000. (Ed.). Academic Press.
20. Essentials of Conservation Biology. Primack, R.B. 1998. Sinauer Associates.
21. Conservation Biology. Pullin, A.S. 2002. Cambridge University Press, UK.
22. Essentials of Ecology and Environmental Science. Rana, S.V.S. 2005. Prentice Hall of India, New Delhi.
23. Ecology, Environment, and Resource Conservation. Singh, J. S., Singh, S. P. and Gupta, S. R. 2006. Anamaya Publ., New Delhi.
24. Elements of Ecology. (6<sup>th</sup> edn.). Smith, T.M. and Smith, R.L. 2006. Pearson. New Delhi.
25. Conservation Biology. Soule, M.E. 1986. (Ed.). Sinauer Associates, New York.

26. The Living Landscape: An Ecological Approach to Landscape Planning, 2nd Edition. Steiner, F. 1999. McGraw Hill, Inc., New York.

**ZOL 312D: PRACTICAL-VI**

**Scheme for Practical Examination**  
(Based on ZOL 3D01, ZOL 3D02 and ZOL 3D03)

**Max Marks: 100**

**Time: 6 hrs**

**Max Marks 100**

**Time 6 hrs**

1. Exercise 1	20
2. Exercise 2	16
3. Exercise 3	10
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

**Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.**

**M.Sc. ZOOLOGY III SEMESTER**

**ELECTIVE GROUP E (SPECIAL PAPER)**

**ZOL 3 E01: REPRODUCTIVE BIOLOGY**

**ENDOCRINE GLANDS AND HORMONES**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

**Endocrine glands: An overview, basic concepts of endocrinology**

**Vertebrate endocrine glands: Study of the major endocrine glands of vertebrate. Structure, secretions and physiology (With the special emphasis on the role in reproduction):**

1. The pituitary gland
2. Thyroid
3. Parathyroid
4. Adrenal
5. Pineal
6. Pancreas
7. Gastrointestinal tract

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## UNIT-II

### Hormones:

1. Classification and characteristics of hormones
2. Chemical nature of hormones
3. Hormonal regulation
4. Feedback mechanism.

### Steroid hormones:

1. Structure and nomenclature
2. Steroidogenesis.

## UNIT-III

### Hormone actions:

1. Transportation of hormones
2. Receptors and target cells
3. Mechanism of action of hormones.

**Prostaglandins:** Chemistry, mechanism of action and their role in reproduction.

### Pheromones:

1. Mammalian and insect pheromones
2. Applications of pheromones
3. Fertility control in insects
4. Induced spawning in fishes and amphibians.

## UNIT-IV

### Invertebrate endocrine glands:

Anatomy and physiology of the endocrine and neuroendocrine structures of

1. Annelids
2. Arthropods
3. Mollusca (with special reference to their role in reproduction)

## M.Sc. ZOOLOGY III SEMESTER

### ELECTIVE GROUP E (SPECIAL PAPER)

### ZOL 3E02: REPRODUCTIVE BIOLOGY

### MALE AND FEMALE REPRODUCTIVE SYSTEMS

Max. Marks: 100

Total Hours: 60

The female reproductive system:

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1. Comparative anatomy and physiology of the mammalian and sub mammalian ovary and ductal system.
2. Follicular growth, kinetics and atresia.
3. Mechanism of ovulation, ovarian hormones, two cell theory of estrogen biosynthesis.
4. Autocrine, paracrine and endocrine regulation of ovarian functions.

#### UNIT-II

##### The male reproductive system:

1. Comparative anatomy and physiology of the mammalian and sub mammalian testis.
2. Functional organization of testis, spermatogenic cycle.
3. Testicular androgens, autocrine, paracrine, and endocrine regulation of testicular functions.
4. Epididymis and the sex accessory glands, semen and its biochemistry.

#### UNIT-III

##### Regulation of reproduction:

1. Hypothalamus and its neurosecretory centres: Structure of neurosecretory cells, the hypothalamic principles: synthesis, storage, release and chemistry.
2. The phenomenon of neuroendocrine integration and the hypothalamo-hypophyseal gonadal axis.

#### UNIT-IV

##### Biology of Sex-determination and Sex differentiation:

1. Development of gonads
2. Development of genital ducts and accessory organs
3. Development of external genitalia.
4. Sex determination in mammals.

### M.Sc. ZOOLOGY III SEMESTER

#### ELECTIVE GROUP E (SPECIAL PAPER)

#### ZOL 3 E03: REPRODUCTIVE BIOLOGY

#### BIOLOGY OF GAMETES, REPRODUCTIVE CYCLES AND BEHAVIOUR

Max. Marks: 100

Total Hours: 60

#### UNIT - I

##### Biology of spermatozoa and ovum:

1. Structure, development and function of spermatozoa and ovum.
2. Hormonal regulation of reproductive behaviour.

#### UNIT-II

##### Breeding seasons and reproductive cycles and their hormonal regulation (Brief account):

1. Breeding seasons in vertebrates
2. Types of reproductive cycles
3. Estrous cycle
4. Menstrual cycle

#### UNIT-III

##### Puberty, adolescence and menopause:

1. Onset of puberty
2. Hormonal control of onset of puberty
3. Precocious and delayed puberty
4. Menopause and climacteric

#### UNIT-IV

##### Impact of aging on male and female reproduction:

1. Andropause
2. Menopause
3. Hormone replacement therapy

##### Practicals

1. Location and identification of various endocrine glands in rodents
2. Anatomy of male reproductive systems.
3. Anatomy of female reproductive systems
4. Microtomy: Histology of male and female genital organs and endocrine glands in normal and pathological conditions
5. Staining of permanent slides of endocrine glands
6. Morphometry of spermatozoa
7. Study of the permanent histological slides-mammalian and sub mammalian
8. Monitoring of vaginal smear.
9. Permanent slide preparation of vaginal smear
10. Sperm density & sperm motility
11. Eosin - Nigrosin stain for live & dead spermatozoa

**Note:** It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

##### Recommended Books

1. Biology of Gestation. Assali, N. S. (ed.) Vol. I and II Academic Press, New York.
2. An Introduction to General and Comparative Endocrinology by Barrington: E. J. W. Clarendon Press, Oxford, 1963
3. Delayed Implantation Enders, N.C. University of Chicago Press, Chicago, 1963.
4. A Text Book of comparative Endocrinology. Gorbman, A and Bern, H. A. John Wiley and Sons Inc., New York, 1962. (Indian reprint, Wiley Eastern Pvt. Ltd., New Delhi, 1974).
5. Biology of ovarian follicles in Mammals. Guraya, S. S., Springer Verlag, Berlin.
6. Encyclopedia of Reproduction. Vol. I to IV. Knobil E. and Neill J.D. Academic Press, New York, 1998.
7. Reproductive Physiology. Nalbandov. A. S, W H. Freeman and Co., New York, 1964. (Indian Reprint), D. B. Taraporevala, Sons and Co. Ltd., Bombay, 1970.

8. Andrology Male Reproductive Health and Dysfunction. Nieschlag F. and Behre H.M Springer-Verlag, Berlin-2001
9. Hormones. Norman A.W. and Litwack G. Academic Press, New-York, 1997.
10. Marshall's Physiology of Reproduction Parkes. A. S. Vols. 1; Part 1 (1956) and 2 (1960) 3 (1952) and 4 (1966) Longmans, Green and Co., London. .
11. Biology of Human Reproduction. Pinon, Jr. R. University Science Books, California, 2002.
12. The Mammary gland and its Secretion Vol. 1 and II by S. K. Kon and A. T. Cowie. Academic Press, New York.
13. General Endocrinology. Turner, C.D., W B. Saunders and Co., Philadelphia (Tappan International. Edition, Tappan Co. (Singapore) Pvt. Ltd., New Delhi, 1974).
14. Williams Textbook of Endocrinology. Shlomo Melmed, Kenneth Polonsky and P. Reed Larsen ed., SAUNDERS,2007
15. Vertebrate Endocrinology, Norris D.O.
16. Comparative Vertebrate Endocrinology, Benttey P.
17. Human Physiology (Vol. II), C.C. Chatterjee.
18. Sex and Internal Secretions Vols. I and II., Young, W. C.: Baltimore, Williams & Wilkins, 1961.
19. Knobil and Neill's physiology of reproduction, Vol. I and II, Ernst Knobil, Jimmy D. Neill Academic Press, 2006.
20. Yen & Jaffe's Reproductive Endocrinology Jerome Strauss and Robert Barbieri Elsevier 2009.
21. Comparative Reproductive Biology Reviewed. Ali Honaramooz, Blackwell Publishing House, Ames, Iowa, USA, 2007.
22. Molecular Mechanisms in spermatogenesis, Volume 636. C. Yan Cheng, Springer, USA 2008.
23. Essential Reproduction. M. H. Johnson, Barry J. Everitt Blackwell publishing ,USA 2007.

### ZOL 312E: PRACTICAL-VI

#### Scheme for Practical Examination (Based on ZOL 3E01, ZOL 3E02 and 3E03)

Max. Marks: 100

Time: 6 hrs

1. Exercise	16
2. Exercise	16
3. Exercise	16
4. Spotting (8 × 3)	24
5. Seminar	09
6. Viva Voce	10
7. Record	09

#### Note:

1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of dissections/

charts/models/CD- ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.

2. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

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M.Sc. ZOOLOGY IV SEMESTER (2023-24)

CORE PAPER

ZOL: C401: ECOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

Ecosystem: Structure and function:

1. Types of ecosystem
2. Basic structure of ecosystem
3. Physical, chemical & genetic structure of ecosystem
4. Function of ecosystem
5. Energy flow within the ecosystem & Y-shaped mode of energy flow.
6. Productivity.
7. Food chain and trophic levels.
8. Ecological efficiencies.
9. Ecological pyramids.
10. Ecological niche
11. Homeostasis and stability of ecosystem

UNIT-II

Fragile Ecosystems

1. Coral reef ecosystem
2. Mangroves
3. Wetlands
4. Antarctic ecosystem
5. Arctic ecosystem
6. Mountain environment

Population Ecology:

1. Population density, natality, mortality and age distribution
2. Biotic potential of population
3. Growth forms and concept of carrying capacity of population
4. Population dispersal
5. Regulation of population

Unit III

Environmental factors

1. Law of minimum (Leibig's Law)
2. Law of tolerance (Shelford's Law)
3. Combined concept of limiting factors
4. Physiological environment as limiting factor
5. Light, humidity, temperature, fire, atmosphere gases, current and pressure

### Species interactions

1. Biotic environmental factors
2. Competitive Exclusion principle
3. Interspecific and intraspecific interactions.

## UNIT-IV

### Concept of community:

1. Characters and classification of community
2. Community periodism
3. Community stratification, succession & climax
4. Community boundary: Ecotone and edge effects.

### Biogeochemical and nutrient cycles:

1. Nitrogen cycle
2. Carbon cycle
3. Phosphorus cycle
4. Sulfur cycle

### Practicals

1. Estimation of alkalinity, acidity, dissolved oxygen, chloride in water samples.
2. Estimation of nitrogen and phosphorous estimation in soil.
3. Listing of animals around your home/department & comments upon them.
4. Microbial analysis in soil/air/water.
5. Limnological study of a local water body submission of written report.
6. Estimation of population density belt and Quadrates method, Line transect method.

### Recommended Books

1. Ecology, Individuals. Populations and Communities. Begon. M., J.I., Harper and C.R. Townsend, Blackwell Science. Oxford U.
2. Ecological concepts. Cherrett, J.M. Blackwell Sci. Publi. Oxford U.K.
3. Population Biology. Elseth. B.D. and K.M. Baumgartner. Van Nostrand Co., New York
4. Fundamentals of ecological modeling. Jorgenson. SE. Elsevier. New "
5. A New Ecology - Systems Perspective Sven Erik Jørgensen, Brian Fath, Simone Bastianoni, Joao Marques, Felix Muller, S. Nors Nielsen, Bernard Patten, Enzo Tiezzi and Robert Ulanowicz Elsevier May 2007
6. Ecological Census Techniques - A Handbook Edited by William J. Sutherland CUP August 2006
7. The Life of Mammals (Life of Mammals) by David Attenborough
8. Fundamentals of Ecology by Eugene Odum, Gary W. Barrett, Hardcover: 624 pages, Brooks Cole
9. The Science of Ecology by Richard Brewer, Hardcover: 816 pages, Publisher: Brooks Cole
10. Applied Ecology and Environmental Management (2ND 00) Edward I. Newman (Paperback | ISBN10: 0632042656; ISBN13:9780632042654)
11. Applied Ecology and Natural Resource Management (03) Guy R. McPherson and Stephen DeStefano | ISBN10: 051105811X; ISBN13:9780511058110

12. Essentials of Ecology C Townsend, M Begon, J L Harper
13. Essential Environmental Studies. Misra, S P and Pandey S. N. 2009. Ane Books Pvt. Ltd.
14. Field Biology and Ecology. Benton, A.H. and Werner, W.E. 1976. Tata McGraw Hill, New Delhi.
15. Fundamentals of Ecology. Odum, E P. 1996. W.B Saunders College Publishing, Philadelphia.
16. Essentials of Ecology and Environmental Science (4th edn.). Rana, S.V.S. 2009. PHI learning Pvt. Ltd., New Delhi.
17. Ecology and Environmental Biology. P.D. Sharma. Rastogi publication, Meerut.

## M.Sc. ZOOLOGY IV SEMESTER

### CORE PAPER

#### ZOL C402: ETHOLOGY

Max. Marks: 100

Total Hours: 60

#### UNIT-I

**Scientists and their works:** Konrad Lorenz, Niko Tinbergen, Karl Von Frisch, Skinner BF and Harlow Harry, Richard Dawkins, EO Wilson, Desmond Morris.

**Concepts of Ethology** (SS, FAP, ASE, IRM), Flush Toilet model; Genes and behaviour; Evolution of behaviour.

#### UNIT-II

**Neuroethology:**

1. Methods of studying brain and behaviour: Neuroanatomical, neurophysiological and neurochemical.
2. Mammalian brain and behaviour, Limbic system and hypothalamus.
3. Behavioural studies in invertebrates.

#### UNIT-III

**Social behaviour:**

1. Properties and advantages of social grouping, social group of monkeys.
2. Sociobiology-Darwinian fitness, individual fitness, kin selection, group selection. Co-operation, reciprocation, altruism, reciprocal altruism, proximate and ultimate causations
3. Territorial behaviours: home range, territory, core area
4. Aggressive behaviour: Types & causes of aggression, neural and hormonal control.

#### UNIT-IV

1. Feeding and sexual strategies in animals.
2. Courtship and mating behaviour in animals
3. Parental care in animals.
4. Communication in animals: auditory, tactile, visual and chemical.
5. Learning introduction and definition, types of learning, Habituation, trial and error,

- conditioning, cognition and imprinting.
6. Short and long term memory, neural mechanism of learning.

### Practicals

1. Learning by trial and error in animals using maze and jumping box.
2. Study of movement of fish in aquarium.
3. Food preference in Tribolium.
4. Pheromones in Earthworms.
5. Study of exploratory behaviour of rats/mice.
6. Study of grooming, rearing and locomotory behaviour of rats/mice.
7. Nest building behaviour in anyone species of animal (Insects, spiders, fishes, birds and mammals)
8. Reproductive behaviour in anyone species of animal

### Recommended Books

1. Animal behaviour: A synthesis of ethology and comparative psychology. Hinde. R.A. McGraw-Hill. New York.
2. The Life of Mammals, Life of Mammals, by David Attenborough
3. Animal Behaviour — An evolutionary approach, Alcock, John . Sinauer Associates. Animal Behaviour, Barnard, C.J. Croom Helm, London..
4. Modern Ethology, Barnett, S.A. .
5. Ethology: The biological study of Animal Behavior Chauvin, Remy, International Univ. Press).
6. Quantitative Ethology. John. Wiley & Sons. Colgan, Patric W.
7. Introduction to Ethology, Immelman, C.
8. An Introduction to animal behaviour. Manning, Aubrey. Edward Arnold Publ., London.
9. An introduction to animal behaviour. Manning, Aubrey. Addison-Wesley Publ.Co.
10. Essentials of animal behaviour. Slater, P.J.B. Cambridge Univ. Press.
11. The ecology and evolution of animal behavior. Wallace, Robert A. (Goodyear Publ. Co. Inc.). 284 pages.
12. The Science of Ecology by Richard Brewer, Publisher: Brooks Cole
13. Applied Ecology and Environmental Management, Edward I. Newman
14. Applied Ecology and Natural Resource Management Guly R. McPherson and Stephen De Stefano, Cambridge University.
15. Animal Behaviour, Reena Mathur Rastogi Publication

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M.Sc. ZOOLOGY IV SEMESTER

CORE PAPER

ZOL C403: TOOLS AND TECHNIQUES

Max. Marks: 100

Total Hours: 60

UNIT-I

Principle, construction and applications of Microscopy

1. Light Microscopy.
2. Bright field and Dark field Microscopy.
3. Phase contrast Microscopy.
4. Fluorescence Microscopy.
5. Electron Microscopy (TEM & SEM).
6. Confocal and Atomic Force Microscopy.
7. Micrometry.

UNIT-II

Separation Techniques

Centrifugation:

1. Basic principles of sedimentation
2. Types of centrifuges
3. Analytical and preparative centrifugation
4. Differential and density gradient centrifugation

Chromatography:

1. Paper chromatography
2. Thin layer chromatography
3. Ion exchange chromatography
4. Gel permeation chromatography
5. Affinity chromatography
6. Gas chromatography
7. High pressure liquid chromatography (HPLC)

Electrophoresis:

1. Paper electrophoresis
2. Polyacrylamide gel electrophoresis (PAGE) and SDS-PAGE
3. Agarose gel electrophoresis
4. Two Dimensional electrophoresis and Isoelectric focusing
5. Pulse field electrophoresis, Capillary electrophoresis
6. Immunoelectrophoresis
7. Blotting techniques (Southern and Western)
8. DNA sequencing
9. Polymerase Chain Reaction (PCR)

UNIT-III

1. Principle and applications of colorimetry and spectrophotometry; UV-VIS Spectrophotometer.

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2. Spectroscopy: Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic Resonance spectroscopy (NMR).
3. Dosimetry, Ionization chamber, GM counter, Solid and liquid scintillation counters
4. Radioisotopes- types, characteristics and uses, Autoradiography.

#### UNIT-IV

##### Histological techniques:

1. Principles of tissue fixation, factors affecting tissue fixation.
2. Chemical basis of fixation by Formaldehyde, Glutaraldehyde, Chromium salts,
3. Mercury salts, Osmium salts, Alcohol and Acetone.
4. Theory and practice of Microtomy.
5. Staining of carbohydrates, proteins, lipids and nucleic acids.

##### Animal tissue culture techniques:

1. Design of animal tissue culture laboratory and essential instruments required in tissue culture.
2. Sterilization of materials to be used for tissue culture.
3. Culture media, preparation and essential components.
4. Types of tissue culture, organ and organotypic cultures.
5. Primary culture and the establishment of cell lines.
6. Characterization of cell lines.
7. Cell proliferation measurements and cell viability tests.
8. Cryopreservation and retrieval of cells from frozen storage.

##### Practicals

1. Experiments using Fluorescence microscope and Phase contrast Microscope.
2. Measurement of cell size using micrometry.
3. Preparation of samples using different centrifuges.
4. Use of Spectrophotometer for measuring the optical density of different biological samples.
5. Separation of free sugars/amino acids from different samples by paper chromatography.
6. Separation of neutral lipids/ amino acids by Thin Layer Chromatography.
7. Separation of molecules by Ion exchange/ Gel permeation/ Affinity Chromatography (Demonstration).
8. Study the working of (a) Gas Liquid Chromatography (b) HPLC (Demonstration).
9. Separation of protein samples by PAGE/SDS-PAGE (Demonstration).
10. Isolation of Genomic DNA from blood or any other sample.
11. Study the working of PCR (Demonstration).
12. Agarose gel electrophoresis of DNA.
13. Study of DNA digestion using restriction enzymes and their separation.
14. Visit to animal tissue culture laboratory (Report to be submitted).
15. Viable cell counting with hemocytometer (Dye exclusion method).
16. MTT and XTT Assay.
17. Fixing, dehydrating, embedding, section-cutting, staining and mounting of different tissues.
  - Candidates are expected to prepare a record of practical works
  - Twenty five (25) slides of serial sections and five (5) tissue blocks shall be submitted at the time of practical examination.

- Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

#### Recommended Books

1. Principle and Techniques of Practical Biochemistry; Wilson & Keith. Cambridge publications.
2. Biotechniques: Theory and Practice; SVS Rana. Rasthogi publications, Meerut.
3. Principles and Practice of Animal Tissue Culture; Sudha Gangal. Universities Press, Hyderabad.
4. Physical Biochemistry; David Freifelder. Freeman publications
5. Instrumental Methods of Chemical Analysis. G.R Chatwal and S.K. Anand. Himalaya Publishing House
6. Theory and Practice of Histological Techniques. John D Bancroft and Marilyn Gamble. Churchill Livingstone Elsevier.
7. Culture of Animal Cells- A Manual of Basic Techniques and Specialized Applications. R. Ian Freshney. Wiley- Black Well.

### ZOL 411: PRACTICAL-VII

(Based on ZOL C401/ ZOL C402/ ZOL C403)

#### Scheme for Practical Examination

Max. Marks: 100

Time: 6 hrs

1. Exercise (Core 1)	16
2. Exercise (Core 2)	15
3. Exercise (Core3)	15
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

*Rj/Tas*  
 By: *Raj*  
 (Signature)  
 Under the supervision of  
 (Signature) *Bay*

**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP A (SPECIAL PAPER)  
ZOL 4 A01: CANCER & RADIATION BIOLOGY  
NATURE & TYPES OF CANCER**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

**Cancer epidemiology:**

1. Global aspects of cancer.
2. Cancer problem in India.
3. Geographic and environmental risk factors (tobacco, alcohol, physical factors, occupational exposure, and environmental carcinogens).
4. Cancer of different age groups and sex.
5. Nutrition and food.

**UNIT-II**

**Classification of tumors:**

1. Benign and malignant.
2. Carcinoma and sarcoma.
3. Leukemia and lymphoma.
4. Epithelial and non-epithelial tumors.
5. Specialized tumors-Mixed salivary gland tumors, uterine carcinosarcoma, teratocarcinoma.

**UNIT-III**

**Characteristics of tumors:**

1. General properties of cancer cells.
2. Staging and grading.
3. Clinical gross and microscopic features.
4. Rate of tumor growth.
5. Local invasion and metastasis
6. Angiogenesis

**UNIT-IV**

**Common types of cancer (signs, symptoms, prevention and treatment):**

1. Oral cancer.
2. Stomach cancer.
3. Liver cancer.
4. Lung cancer.
5. Prostate cancer.
6. Skin cancer.
7. Breast cancer.
8. Gynecological cancers.
9. Blood cancer.

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**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP A (SPECIAL PAPER)  
ZOL 4 A02: CANCER & RADIATION BIOLOGY**



## MOLECULAR MECHANISM OF CANCER

Max. Marks: 100

Total Hours: 60

### UNIT-I

#### Cancer genetics:

1. Proto-oncogenes and oncogenes
2. Tumor suppressor genes
3. Hereditary cancer
4. Cancer epigenetics(DNA methylation, Histone modification)
5. Telomeres and immortalization

### UNIT-III

#### Signaling Pathways in Cancer

1. Ras-RAF-MEK-ERK pathway: Role in cancer cell proliferation and survival
2. PI3K-AKT-mTOR pathway: Impact on cell growth and metabolism
3. Wnt/ $\beta$ -catenin, and Notch pathways: Influence on cell fate, differentiation and self-renewal

### UNIT-III

#### Tumor Microenvironment

1. Tumor microenvironment and its impact on cancer progression
2. Introduction to the components of the tumor microenvironment: Stromal Cells, Immune cells, Cancer Cells, Extracellular Matrix (ECM), Blood Vessels, Cytokines and Chemokines
3. Tumor microenvironment and cancer therapy resistance

### Unit-IV

#### Cancer Bioinformatics

1. Introduction to bioinformatics tools (e.g., BLAST, UCSC Genome Browser)
2. Data formats used in cancer bioinformatics (FASTA, FASTQ, SAM/BAM, VCF, etc.)
3. Biological databases relevant to cancer research: TCGA, CCLE, ICGC, GDC, GDSC, COSMIC, TARGET
4. Introduction to cancer genomics and transcriptomics

M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP A (SPECIAL PAPER)  
ZOL 4A03: CANCER & RADIATION BIOLOGY  
TUMOR IMMUNOLOGY AND TREATMENT

Max. Marks: 100

Total Hours: 60

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## UNIT-I

### Apoptosis and cancer:

1. Cell death, Apoptosis and Necrosis.
2. Caspases.
3. BCl<sub>2</sub> family proteins.
4. Extrinsic and Intrinsic mitochondrial pathway.
5. Inhibitors of apoptotic protein.
6. Role of apoptosis in cancer.

## UNIT-II

### Diagnosis and prevention of cancer:

1. Tumor markers.
2. Histological and cytological methods.
3. Histochemistry and cytochemistry methods.
4. Immunohistochemistry and biochemical assays.
5. PET, CAT, MRI Scans'
6. Modern aids in tumor diagnosis.

## UNIT-III

### Tumor immunology:

1. Immune suppression and role of immune surveillance in growth of tumors.
2. Tumor specific antigens and immune response.
3. Modulation of immune response
4. Cancer vaccines
5. Managing immune-related adverse events

## UNIT-IV

### Treatment of cancer:

1. Surgery.
2. Radiation therapy.
3. Chemotherapy.
4. Hormone therapy.
5. Targeted therapy (Immunotherapy, CAR-T cell therapy, Small molecule based therapy, Nanomedicine and drug delivery systems)
6. Gene Therapy

### Practicals

1. Sarcomas, Carcinomas, Leukemias, teratocarcinomas.
2. Tumor induction,
3. Skin carcinogenesis in mice.
4. Cervical carcinogenesis in mice.
5. Short term carcinogenicity tests.
6. Chromosomal aberrations.
7. Micronucleus test.
8. Image analysis of tumor markers expression
9. Breast cancer: Staging and Grading
10. Chemoprevention of chemical carcinogenesis.
11. Morphological, histopathological and biochemical studies of various cancerous tissues.
12. Study of Pre-cancerous and cancerous lesions of oral cancer, breast cancer, cervix

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cancer, prostate cancer etc.

13. Visit to Radiotherapy Department, S. M. S. Medical College, Jaipur; Sri BhagwanMahaveer Cancer Hospital, Jaipur and Tata Memorial Cancer Hospital, Mumbai.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

### Recommended Books

1. Who runs the risk of cancer. A. Ramesha Rao. Shipra publication.
2. Targeted Therapies in Cancer, Craig A. Almeida, Publisher: Springer.
3. Cancer, Publisher: Craig A. Almeida, Oxford University Press, USA.
4. Cancer Prevention, Devita VT, Heilmos, Rosensy, S. A. J. B. Lippincott.
5. Pathology of Diseases, S. Lotran, V. Kumar, T. Collins. Robbins.
6. The Basic science of oncology. Tannode, I F and Richard P. Th. II MacGraw, Hill.
7. Basic pathology. Vinay Kumar, Ramzi, S. Contran and Stranley L. Robbins. Thomson press Ltd. NOIDA, 1999.
8. Principals of metastases. Weiss, L. Academic press.
9. Principles of Cancer Biology. Lewis J. Kleinsmith, Publisher: Benjamin Cummings.
10. The biology of Cancer, Robert A. Weinberg, Publisher: Garland Science.
11. Lauren Pecorino, Cellular and Molecular Biology of Cancer, Publisher: Oxford University Press, USA.
12. Lauren Pecorino, Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Published May 1st 2005 by Oxford University Press, USA (first published 2005).
13. Biology of Cancer, Randall W. Phillis, Publisher: Benjamin Cummings.
14. Cancer of System Biology, Randall W. Phillis, Publisher: CRC Press
15. The Biology and Treatment of Cancer, Arthur B. Pardee, Publisher: Wiley-Blackwell.
16. Cancer Systems Biology, Edwin Wang, May 4, 2010 by CRC Press.
17. Introduction to Cancer Biology, Robin Hesketh, University of Cambridge, January 2013.
18. The Biology of Cancer Paperback – Robert A. Weinberg, Garland Science; 1 Pck Pap/ edition

**ZOL 412A: PRACTICAL-VIII**  
**Scheme for Practical Examination**  
**(Based on ZOL 4A01, ZOL 4A02 and ZOL 4A03)**

Max Marks: 100

Time 6 hrs.

1. Exercise 1	20
2. Exercise 2	16
3 Exercise 3	10
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

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M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP B (SPECIAL PAPER)  
ZOL 4B01: CELL AND MOLECULAR BIOLOGY

BASIC IMMUNOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

**Molecular immunology:**

1. Innate (non-specific) immunity
  - (i) Anatomic barriers.
  - (ii) Physiological barriers.
  - (iii) Chemical mediators
  - (iv) Phagocytic / endocytic barriers
  - (v) Inflammatory barriers
2. Adaptive (specific) immunity

**Cells and organs of immune system:**

1. Cells of immune system.
2. Organs of immune system
  - (i) Primary lymphoid organs (Thymus and bone marrow) & Thymic education.
  - (ii) Secondary lymphoid organs (Lymph nodes, spleen, mucosal associated lymphoid tissue and cutaneous associated lymphoid tissue, tonsils and Peyer's patches).
  - (iii) Lymphatic system.

UNIT-II

**Haematopoiesis**

1. Haematopoiesis growth factors, Genes involved in haematopoiesis
2. T-cell lineage
3. B-cell lineage

**Immune response:**

1. Phases of Immune response
  - (i) Cognitive.
  - (ii) Activation.
  - (iii) Effector.
  - (iv) Clonal selection hypothesis.
2. Humoral and cell-mediated immune responses (CMI)
  - (i) Recognition of antigen by B-and T-lymphocytes and antigen presenting cell
  - (ii) Clonal selection of lymphocytes
3. Cellular interactions required for generation of immune responses
  - (i) Activation and proliferation of B and T cells
  - (ii) Generation of humoral immune responses
  - (iii) Generation of CMI and cell mediated cytotoxicity

UNIT-III

**Antigens:**

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By Registrar  
Academic  
University of Rajasthan

1. Immunogenicity versus antigenicity
2. Factors that influence immunogenicity
  - (i) Contribution of immunogens (foreignness, molecular size, chemical composition and heterogeneity, susceptibility to antigen processing and presentation).
  - (ii) Haptens and epitopes
  - (iii) Immunogen dosage and route of administration and adjuvants
3. Structural aspects of antigens

**Immunoglobulins Structure and Function:**

1. Molecular structure of Ig
2. Immunoglobulin classes (IgG, IgM, IgE, IgA and IgD) and their biological activities
3. Immunoglobulin - mediated effector functions (Opsonization, activation of complement, antibody dependent cell-mediated cytotoxicity, neutralization)
4. Antigenic determinants on immunoglobulin (isotype, allotype and idiotypic).

**UNIT-IV**

**Organization and Expression of Ig Genes:**

1. Genetic model compatible with Ig structure.
2. Multigene organization of Ig genes
3. Mechanism of variable region DNA rearrangement
4. Generation and antibody diversity
5. Class switching among constant region genes, Expression of Ig genes

**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP B (SPECIAL PAPER)  
ZOL 4B02: CELL AND MOLECULAR BIOLOGY**

**IMMUNOLOGY: MOLECULAR EXPRESSION AND FUNCTION**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Monoclonal Antibodies:**

1. Formation and selection of hybrid cells
2. Production of monoclonal antibodies
3. Clinical uses of monoclonal antibodies
4. Catalytic monoclonal antibodies (abzymes).

**Antigen-antibody Interaction:**

1. Antibody affinity and avidity.
2. Cross reactivity.
3. Agglutination reactions.
4. Precipitation reactions.
5. Complement & its regulation; complement fixation test.

**UNIT-II**

**Major Histocompatibility Complex:**

1. General organization and inheritance of MHC.
  - (i) Location and function of MHC.
  - (ii) MHC haplotypes.

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2. MHC molecules and genes
  - (i) Structure of class I molecules.
  - (ii) Structure of class II molecules
  - (iii) Organization of class I and II genes.
  - (iv) Peptide binding by MHC molecules.
  - (v) Class III molecules
3. Regulation of MHC expression.

#### Antigen Processing and Presentation

1. Role of antigen presenting cell
2. Evidence for two processing and presentation pathways.
  - (i) Endogenous antigens. The cytosolic pathways, Peptide generation by proteosomes, Peptide transport from the cytosol to rER, Assembly of peptide with class I MHC molecules.
  - (ii) Exogenous antigens. The endocytic pathway, Peptide generation in endocytic vesicles, Transport of class II MHC molecules to endocytic vesicles, Assembly of peptide with class II MHC molecules.

### UNIT-III

#### Cytokines:

1. Properties of cytokines.
2. General structure of cytokines.
3. Types of cytokines.
4. Function of cytokines.
5. Cytokines related diseases
  - (i) Bacterial septic shock.
  - (ii) Bacterial toxic shock and similar diseases.
  - (iii) Lymphoid and myeloid cancers.
  - (iv) Chagas disease.

### UNIT-IV

#### Immune System in Health and Disease:

1. Immune response to infectious diseases: Viral infections, Viral neutralization by humoral antibody, Cell - mediated antiviral mechanism, Viral evasion of host defense mechanisms.
2. Immune response to Bacterial infections, Immune responses to extracellular and Intracellular bacteria, bacterial evasion of host defense mechanism.
3. Immune response to Protozoa and diseases-*Trypanosoma*
4. Immune response to Diseases caused by helminthes.

### M.Sc. ZOOLOGY IV SEMESTER

#### SPECIAL PAPER

#### ZOL 4 B03: CELL AND MOLECULAR BIOLOGY

#### IMMUNOLOGY: APPLICATION AND CELLULAR MALFUNCTION

Max. Marks: 100

Total Hours: 60

### UNIT-I

#### Vaccines:

1. Characteristics of vaccine.

2. Active and passive immunization.
3. Immunization schedule (Recommended by Indian Academy of Pediatrics)
4. Designing vaccines for active immunization.
5. Types of vaccines: Whole organism vaccine: Attenuated vaccines, inactivated vaccines; polysaccharide vaccines, synthetic peptide vaccines, vaccines, Recombinant vector vaccines, DNA vaccines.

#### UNIT-II

##### Immunodeficiencies:

1. Primary immunodeficiency:
  - (i) Lymphoid - Severe Combined Immunodeficiency, Defects in B-cell maturation, Defects in T-cell development
  - (ii) Myeloid lineage – Chronic Granulomatous Disease, Leukocyte Adhesion Deficiency, Chediak –Higashi syndrome & Neutropenia or Granulocytopenia.
2. Secondary immunodeficiency: AIDS- genome organization, replication, opportunistic agents, immunologic abnormalities associated with HIV infection and therapeutic agents.

#### UNIT-III

##### Hypersensitivity:

1. Type I, II, III and IV

##### Tolerance and autoimmunity:

1. General features of immunologic tolerance.
2. T - and B - cell tolerance; Induction of tolerance.
3. Organ specific autoimmune disease.
4. Systemic autoimmune disease.

#### UNIT-IV

##### Tumor immunology:

1. Tumor antigen.
2. Immune response to tumors (T-cell mediated; NK cell and macrophage mediated)
3. Tumor evasion.
4. Therapies.

##### Transplantation immunology:

1. Acute, hyper acute and chronic rejection
2. Tissue matching (HLA typing)
3. Graft Vs host (GVH) reaction
4. Xenotransplantation
5. Immunosuppressive drugs; role of monoclonal antibodies in transplantation

##### Practicals

1. Immunization routes: Intradermal, subcutaneous, intramuscular, intraperitoneal, intravenous, foot pad.
2. Bleeding schedules and collection of blood from ear.
3. Preparation of antigen to raise antibodies; raising antibodies in animal model.
4. Serum preparation, Storage and preservation of serum.
5. Isolation of macrophages from peritoneal cavity of mice.
6. Purification of antibodies and antigens: Immuno-adsorption or Affinity

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- chromatography (antibody purification).
7. Differential staining of leucocytes.
  8. Isolation and fractionation of mononuclear cell population (T and B cells).
  9. Rosette formation of T-cells from red blood cells.
  10. Agglutination test – Widal test or C-reactive protein (CRP).
  11. Immunodiffusion methods-Radial (RID).
  12. Ouchterlony Double Diffusion (ODD).
  13. Immunoelectrophoresis -RIE.
  14. Immunoassay: ELISA.
  15. Permanent slides: Thymus, bone marrow, spleen, Lymph node, and slides related to experiments.

**Note:** It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

#### Recommended Books

1. Immunology. Brostoff D and Roitt IM. 7<sup>th</sup> edition Mosby & Elsevier Publishing, Canada, USA. 2006.
2. Understanding the Immune System. Elgert KD. Immunology. Wiley –Blackwell USA. 2009.
3. Immunobiology. Goldsby RA, Kindt TJ, Osborne BA and Kuby J. 5<sup>th</sup> edition. W.H. Freeman & Co. Ltd. 2002.
4. Immunobiology –The immune system in Health and Disease. Janeway CA Jr, Travers P, Walport M & Shlomchik MJ. 5<sup>th</sup> edition. Garland Science Publishing NY, USA 2001.
5. Immunobiology –The immune system in Health and Disease. Janeway CA Jr, Travers P, Walport M & Shlomchik MJ. 6<sup>th</sup> edition. Garland Science Publishing NY, USA 2005.
6. Elements of Immunology. Pearson Higher Education, Khan FH. New Delhi 2009.
7. Immunology. Kuby J, Goldsby RA, Kindt TJ, Osborne BA. 4<sup>th</sup> edition. W.H. Freeman & Co. Ltd. 2000.
8. Janeway's Immunobiology. Murphy K. 8<sup>th</sup> edition. Garland Science 2011.
9. Immunology. Owen J, Punt J & Stranford S. Kuby. 7<sup>th</sup> edition. W.H. Freeman & Co. Ltd. 2013.
10. Fundamental Immunology. Paul WE. 7<sup>th</sup> edition. Lippincott Williams & Wilkins. 2012.
11. Tizard IR. Immunology .An Introduction 4<sup>th</sup> edition Thompson Asia Pvt. Ltd. Singapore. 1984.
12. Roitt's Essential Immunology, Delves PJ, Martin SJ, Burton DR and Roitt IM. 11<sup>th</sup> edition, Blackwell Publishing /Oxford University Press. 2006.
13. Kuby Immunology, Kindt TJ, Goldsby RA, Osborne BA and Kuby J. 6<sup>th</sup> edition, WH Freeman, New York 2006.

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**ZOL 412B: PRACTICAL-VIII**

**Scheme for Practical Examination**  
(Based on ZOL 4B01, ZOL 4B02 and 4B03)

**Max. Marks: 100**

**Time: 6 hrs**

1. Exercise 1	20
1. Exercise 2	16
3 Exercise 3	10
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

**M. SC ZOOLOGY IV SEMESTER**  
**ELECTIVE GROUP C (SPECIAL PAPER)**  
**ZOL 4C01: ENTOMOLOGY**  
**INSECT PESTS**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

1. Pest-definition and ecology, pest status, Economic injury level, Economic threshold level, action threshold, pest spectrum, carrying capacity, secondary outbreak, pest surveillance and sampling. Agro-ecosystem and phases of pest population fluctuations.
2. Bionomics, distribution, mode of damage caused and management of major polyphagous pests –
  - a. Locust
  - b. Termites
  - c. white grubs
  - d. Army worm.
  - e. Aphids
  - f. Gram pod borer

**UNIT-II**

Bionomics, distribution, mode of damage caused and management of –

1. Pests of cash crops
2. Pests of sugar cane
3. Pests of tobacco
4. Pests of cotton

**UNIT-III**

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Bionomics, distribution, mode of damage caused and management of-

1. Pests of cereal crops: maize, millet wheat, paddy, sorghum, pulses.
2. Pests of vegetables
3. Pests of fruits
4. Pests of oil seed crops

#### UNIT-IV

Bionomics, distribution, mode of damage caused and management of -

1. Pests of stored grains and milled products
2. Methods of safe storage.
3. Insect vectors transmitting bacteria, protozoans and viruses of medically and veterinary importance: fleas,lice,bugs, mosquitoes and flies.
4. House hold pests: Cockroaches, crickets, ants, wasps, clothes moth, silver fish, carpet beetles, furniture beetles and book lice.

**M. SC ZOOLOGY IV SEMESTER  
ELECTIVE GROUP C (SPECIAL PAPER)  
ZOL 4C02: ENTOMOLOGY  
INSECT PEST MANAGEMENT**

**Max. Marks: 100**

**Total Hours: 60**

#### UNIT-I

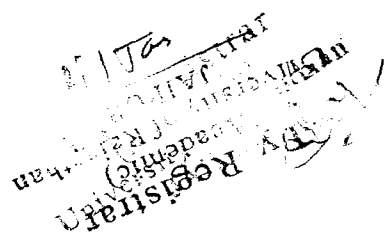
Definition and history of various methods of insect pest control-

1. Physical
2. Mechanical
3. Cultural
4. Behavioural: semiochemicals, pheromones and allelochemicals
5. Quarantine regulations

#### UNIT-II

1. Chemical control
  - a. Nomenclature and classification of insecticides (I, II and III generation pesticides), Pesticide acts of India and pesticide registration.
  - b. Inorganic and synthetic organic insecticides
  - c. Botanical pesticides.
  - d. Insect Growth Regulators, attractants, repellents and antifeedants
2. Mode of action, metabolism and degradation of insecticides.
3. Mechanism of insecticide resistance in insects and resurgence.

#### UNIT-III



1. Biological control: Definition, Biological control agents: pathogens, predators, parasites and parasitoids, Mass production, inoculation and augmentation, advantages and disadvantages.
2. Genetic and Biotechnological control: methods of genetic manipulation and sterilisation, transgenic plants, transgenic biocontrol agents, environmental impact of biotechnological control.
3. Integrated pest management (IPM): concepts, principles, components, constraints and strategies of IPM implementation for the management of major pests in crop fields.

#### UNIT-IV

1. Plant resistance to insects: types of resistance, mechanism of resistance: antibiosis, antixenosis, tolerance, factors mediating resistance, JH, mimics and MH agonist (paper factor).
2. Application of insecticides
  - a. Selection and formulation of insecticides, synergists, antagonists, adjuvants.
  - b. Appliances used for application.
3. Impact of climate change on insect pests.

**M. SC ZOOLOGY IV SEMESTER  
ELECTIVE GROUP C (SPECIAL PAPER)  
ZOL 4C03: ENTOMOLOGY  
APPLIED ENTOMOLOGY**

Max. Marks: 100

Total Hours: 60

#### UNIT-I

1. Forensic entomology: Insects of forensic importance-Order Diptera- Calliphoridae, Sarcophagidae and Muscidae; Order Coleoptera -Staphylinidae, Histeridae, Silphidae, Dermestidae and Cleridae. Collection of entomological evidence during a death investigation from cadaver site. Temperature and climatic records, collection, preservation and handling of insects/maggots from the crime scene. Analysis of entomological evidence and estimating PMI (Post Mortem Index) using Maggot age and Insect succession on corpse. Forensic entomology in wildlife investigation.
2. Entomophagy: nutritional value of insects and future prospects for food and food security. Insect as food (Entomophagy), Insect as medicine (Entomotherapy), Insect as weapons (Entomological warfare), Insect as pets

#### UNIT-II

1. Insect aided pollination: pollinator evolution and diversity, foraging economics and the importance of pollinators in agriculture and ecosystem sustainability, Native pollinators decline and conservation.
2. Apiculture: kinds of honey bees, beekeeping methods, apiary management. Apiculture in India and problems related to its industry.

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### UNIT-III

1. Sericulture: mulberry, non-mulberry sericulture, cultivation, bioecology and rearing of silkworms, structure and chemical composition of silk. Sericulture in India and problems related to its industry.
2. Lac culture: life history of lac insects, host plant management, strains of lac insects, propagation of lac insects, lac crop management. Lac culture in India and problems related to its industry.

### UNIT-IV

1. Impact of pesticides on wildlife and human health. Carcinogenic, mutagenic and teratogenic effects.
2. Bio-concentration, bio-accumulation, biomagnifications.
3. Biological half-life and biodegradation of pesticides (microbial and environmental degradation).
4. Dynamics of environmental pollution due to pesticides.

### PRACTICALS

1. Anatomy:
  - a. Honey bee: Alimentary canal, Nervous system.
  - b. House fly: Nervous system.
  - c. Flesh fly: Cephalopharyngeal skeleton and spiracles of larval stage
2. Permanent Mounting
  - a. Sting apparatus and pollen basket of honey bee.
  - b. Salivary glands of mosquito, *Drosophilla* and honey bee.
  - c. Whole mounts of thrips and aphids.
3. Toxicology
  - a. Bioassay ( $LC_{50}$  and  $LD_{50}$ )
  - b. Pheromone trap functioning
  - c. Pesticide residue analysis of contaminated soil, vegetables and water.
4. Appliances
  - a. Dusters (manually and powered operated)
  - b. Sprayers (manually and powered operated)
  - c. Fumigators
5. Study of selected insects
  - a. Collection and preservation of Odonata, Coleopteran, Lepidopteran, Hymenopteran, Dipteran etc., insects
  - b. Study of selected insects and their identification with the help of taxonomic keys.
6. Insect rearing
  - a. Stored grain pests
  - b. Polyphagous pests
  - c. Flesh flies

- d. Mosquitoes
  - e. *Drosophila*
7. Field trips for pest surveillance.

### Recommended Books

1. A. D. Imms (1997): A General textbook of entomology, Asia Publication.
2. V.B. Awasthi (2021): Agricultural insect pests and their control (2<sup>nd</sup> revised edition), Scientific Publication.
3. M. M. Trigunayat (2016): A manual of practical entomology (3<sup>rd</sup> revised edition), Scientific Publication.
4. A. Prakash and P.G. Fennemore (2014): Applied Entomology, International (P) Ltd., New Age Publishers.
5. V.B. Awasthi (2009): Introduction to entomology and Applied Entomology, Scientific Publication.
6. D.B. Tembhare (1984): A Text book of insect morphology, physiology and endocrinology, Chand Publication.
7. C.L. Metcalf and W.P. Flint (1951): Destructive and Useful Insects, McGraw Hill Publication.
8. G.S. Shukla and V.B. Upadhdhaya (2022): Economic Zoology (5<sup>th</sup> edition), Rastogi Publication.
9. A.V. Huis, J.V. Itterbeeck, H. Klunder, E. Mertens, A. Halloran, G. Muir and P. Vantomme (2013): Edible insects: Future prospects for food and feed security- FAO of the United Nations, Rome (Available online).
10. E. Paul and M.D. Cherniack (2010): Bugs as Drugs, Part 1: Insects. The "New" Alternative Medicine for the 21st Century. Alternative Medicine review.
11. L. P. Pedigo (2014): Entomology and Pest Management (6<sup>th</sup> Edition), Pearson Education.
12. J. H. Byrd and J. L. Castner (2009): Forensic Entomology-The utility of Arthropods in legal investigation (2<sup>nd</sup> Edition), CRC Press.
13. K. K. Nayar, T. N. Ananthkrishnan, B. V David (1976): General and applied Entomology , Tata McGraw Hill
14. D.B. Tembhare (1984): Insect endocrinology and physiology, S Chand publication.
15. R. D. Akre, L. D. Hansen, and R. S. Zack (1991): Insect Jewellery in Summer, Online available as research article.
16. Insect, The Year Book of Agriculture- American Agriculture Department Publication.
17. Irwin, M. E. and Kampmeier, G. E. (2002): Commercial products, from Insect. In V. H. Resh and R. Carde (eds.) Encyclopedia of insects. Academic press, San Diego.
18. A. L. Jeffrey (1987): Entomological warfare: History of the use of insects as weapons of Wars: in Bulletin of the ESA in Summer (Online available as research article).
19. A. Prakash (2001): Laboratory manual of entomology, New Age Publishers.
20. J.S. Castner (2001): Photographic Atlas of Entomology and guide to insect identification, Seline press Florida, Marketed by Scientific Publication.

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21. R.E. Snodgrass (1993): Principles of insect morphology, Tata McGraw Hill.
22. V.B. Wigglesworth (1982): Principles of insect physiology, ELBS Publication.
23. S. Turner (2008): Termites: Friends or Foe, AGRICOLA.
24. H. H. Ross, C. A. Ross, J. P. Ross (1982): A Text book of Entomology, John Wiley publication.
25. R. F. Chapman (1998): The Insects - Structure and Function (4th Edition). Cambridge University Press.
26. T.A. Evans., T. Z. Dawes, P. R. Ward and N. Lo (2011): Ants, and termite increases crop yield in dry climate, Nature communication. 262. doi:10.1038/ncomms1257
27. Kachhwaha, N. and Kaushik, P (2019): freely online available gaming website-innovativezoology.com to study entomology classification.
28. Kachhwaha, N. (2019): Insect Morphology, Physiology and Systematics, Agrobios ISBN 978-81-7754-601-9
29. Kachhwaha, N. (2018): Terminology of Entomology- A brief Dictionary, Ideal International E-Publication Pvt. Ltd. ISBN No. 978-93-86675-59-0 <https://doi.org/10.6084/m9.figshare.14230100.v1>
30. Kachhwaha, N. (2018): Terminology of Entomology- A brief Dictionary, Ideal International E-Publication Pvt. Ltd. ISBN No. 978-93-86675-59-0 <https://doi.org/10.6084/m9.figshare.14230100.v1>
31. Kachhwaha, N., Kumari, V., Meena, G., Meena, S., Kaushik, P., Gaur, A., Rajpurohit, A., Sharma, R., Nagar, G.: MOOC Contribution (Online teaching learning Pedagogy) under Project: Zoology, PG in Zoology (entomology), 12 modules (online lecture) each having four quadrants (I, II, III, IV) in VIDYA MITRA under NME-ICT, MHRD, India <https://vidyamitra.inflibnet.ac.in/index.php/projects>
32. Kumari, V., Choudhary, S. K., Meena, S., Kuri, B. R. and Bamboriya, S. D. (2022) Climate Resilient Agriculture System. Surahee Publications, Jaipur (Raj.)
33. Meena, S., Choudhary, S. K., Kumari, V., Kuri, B. R. and Bamboriya, S. D. (2022) Environment and Food Security. Surahee Publications, Jaipur (Raj.)
34. Choudhary, S. K., Kumari, V., Meena, S. and Singh, S. (2022) Recent Trends in Agricultural Sciences. AnaamayaPrakashan, Jaipur. (Raj.)
35. Choudhary, S. K., Kumari, V., Meena, S. and Singh, S. (2022) Advances in Sustainable Agriculture. AnaamayaPrakashan, Jaipur (Raj.)
36. Kumari, V. and Kachhwaha, N. (2020) Souvenir of National Workshop on skill-based entomology. Ideal International Publication Pvt. Ltd., Indore (MP).
37. Omkar (2017) Industrial Entomology, Springer Nature Singapore Pte Ltd.
38. Omkar (2021) Polyphagous pests of crops, Springer Nature Singapore Pte Ltd.
39. T. D. Schowalter (2011) Insectecology-an ecosystem approach, Elsevier Inc.
40. P W Price, R F Deno, M D Eubanks, D L Finke, I Kaplan (2011) Insect Ecology- Behavior, Populationsand Communities, Cambridge University Press.
41. D Gennard (2012) Forensic entomology, John Wiley & Sons, Ltd

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University of Rajasthan  
JAIPUR

## ZOL 412C: PRACTICAL-VIII

Scheme for Practical Examination  
(Based on ZOL 4C01, ZOL 4C02 and ZOL 4C03)

Max. Marks: 100

Time: 6 hrs

1. Exercise 1	20
2. Exercise 2	16
3. Exercise 3	10
4. Spotting (8 × 3)	24
5. Seminar	10
6. Viva Voce	10
7. Record	10

### Note:

1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of dissections/'charts/models/CD- ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.
2. It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

## M.Sc. ZOOLOGY IV SEMESTER ELECTIVE GROUP D (SPECIAL PAPER) ZOL 4D01: ENVIRONMENTAL BIOLOGY

### ENVIRONMENTAL TOXICOLOGY AND ENVIRONMENTAL HEALTH

Max. Marks: 100

Total Hours: 60

### UNIT-I

#### Ecotoxicology:

1. Definition, scope and history of Toxicology, Fundamental of Ecotoxicology, Acute, Sub-acute and Chronic toxicity, Doses, Dose-Response relationships, LC<sub>50</sub>, LD<sub>50</sub>, Effective Concentration (EC), Maximum Acceptable Toxicant Concentration (MATC), Application Factor (AF), Cumulative toxicity.
2. Toxicity Testing: Definition, purpose, criteria for selection of test organism, methodology, estimation of LC<sub>50</sub> & LD<sub>50</sub>, Limitation and importance of bioassay, teratogenicity, carcinogenicity and mutagenicity. Good Laboratory Practices (GLP).
3. Movement, distribution and fate of toxins in the environment, Bioconcentration, Bioaccumulation, Processes of bioaccumulation, Biomagnification, factors affecting biomagnification.
4. Translocation of xenobiotics: absorption, distribution, biotransformation and excretion.
5. Detoxification mechanisms: Phase I and Phase II reactions.
6. Antidotal Procedures: Classification of Antagonists, Pharmacological assessment of certain antidote actions, Principles of Antidotal treatment, Antidotal procedres.

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## UNIT-II

### Environmental pollution and management:

1. Sources and classification of pollutants, primary and secondary pollutants, Effects of pollutants on human health, animal, vegetation, materials and structures.
2. Air quality standards and monitoring methods; Water quality standard for potability- Pollution parameters, BOD, COD, Coliform bacteria; Soil quality parameters and test methods. National and International standards of noise, Assessment and measurement of sound; Safety standards of Radiation.
3. Liquid waste management: Treatment of water for potable purpose (mixing, sedimentation, coagulation, filtration and disinfection), Primary and secondary treatment. Sludge disposal. Biological treatment: Kinetics of Biological growth activated sludge treatment - trickling filters - anaerobic digestion, combined aerobic and anaerobic treatment process, aerobic process. Advanced waste water treatment - removal of dissolved organic and inorganic - precipitation, iron exchange, reverse osmosis, electro dialysis, adsorption and oxidation.
4. Water pollution treatment using constructed wetlands, Bioremediation.
5. Solid Waste Management: Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing and resources recovery and recycling. Aerobic and anaerobic systems- composting,vermicomposting; Bio-digesters (Biogas plants); incineration, pyrolysis, plasma pyrolysis; sanitary landfills and open dumping yards.
6. Management of plastic and e-waste. Treatment processes for unsegregated waste, fixation of hazardous solid waste prior to disposal, hazardous waste in land fill.Reduction, Recycling and Reuse (3Rs) of waste. Waste minimization techniques.Hazardous waste (Management and Handling) Rules 1989 - the Manufacture Storage and Import of Hazardous Chemicals Rules 1989 - Biomedical Waste (Management and Handling) Rules 1998 -Plastic Act 1999. Extended producer responsibility.

## UNIT-III

### Toxicants of public health and occupational health:

1. Toxicity of Pesticides: Organochlorines, Organophosphates, Carbamates and Pyrethroids.
2. Toxicity of heavy metals and metalloids: Arsenic, Mercury, Lead, Aluminum, Cadmium, Chromium and Copper.
3. Toxicity of solvents: (a). Aliphatic solvents-Carbon tetrachloride, Chloroform, Trichloroethylene, tetra chloro ethylene. (b). Aromatic hydrocarbons-Benzene, Toluene, Xylene, styrene. (c). Alcohols-Methanol, Ethanol
4. Food additives: Antioxidants, Emulsifiers, Flavouring agents, Colours and Preservatives, Artificial sweetening agents.
5. Occupational hazards and diseases: Physical hazards (Heat and cold, light, noise, vibration, ultraviolet radiation, ionizing radiation), Chemical hazards (Mustard gas, Nerve agents, Lewisite, Phosgene oxime, Cyanide), Biological hazards (Anthrax, Leptospirosis, Psittacosis, Botulism, Brucellosis, Cholera, Gas Gangrene, Ebola hemorrhage Fever, Melioidosis, Q fever, Rift Vally fever, Ricin, Saxitoxin, Mycotoxicosis, Tularemia). Psychosocial hazards and diseases.
6. Pneumoconiosis: Silicosis, Anthracosis, Byssinosis, Bagassosis, Asbestosis, Farmers lung.Occupational cancers, Radiation hazards.



#### UNIT-IV

##### Environmental impact and risk assessment:

(10 hrs.)

1. Definition, Scope, Characteristics, Objectives and Components.
2. EIA process and methodology; Procedure for obtaining EIA clearance; Preparation of EIA document; Major limitations of EIA; EIA Case Studies.
3. Prediction and assessment of impacts on earth resources.
4. Risk Assessment: Hazard identification, classification, toxicity assessment, exposure assessment, risk characterization public perception of risk and risk communication.

**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP D (SPECIAL PAPER)  
ZOL 4 D02: ENVIRONMENTAL BIOLOGY  
ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY**

Max. Marks: 100

Total Hours: 60

#### UNIT-I

##### Microbial diversity and metagenomics:

1. Microbial diversity in air, water and soil.
2. Microbial diversity of extreme environments.
3. Introduction to metagenomics.
4. Molecular methods for studying microbial diversity.

#### UNIT-II

##### Microbial interaction with xenobiotic inorganic pollutants:

1. Persistence and Biomagnifications of Xenobiotic molecules.
2. Polychlorinated Biphenyl and Dioxins.
3. Synthetic polymers.
4. Acid Mine Drainage.
5. Microbial methylations.
6. Microbial accumulation of Heavy Metals and Radionuclides.

#### UNIT-III

##### Bioremediation of xenobiotic pollutants:

1. Bioremediation.
2. Environmental modification for Bioremediation.
3. Microbial seeding and Bio-Engineering approaches to the bioremediation of pollutants.
4. Bioremediation of Marine Oil pollutants and Air pollutants.

#### UNIT-IV

##### Use of microorganisms:

1. Recovery of Metals.
2. Recovery of Petroleum.
3. Production of Fuels.

4. Production of microbial biomass.
5. Microbial control of pests.

**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP D (SPECIAL PAPER)  
ZOL 4D03: ENVIRONMENTAL BIOLOGY  
ENVIRONMENTAL EDUCATION, MANGEMENT AND REGULATIONS**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Environmental education:**

1. Knowledge about the environment, knowledge about humanity- environment relationship.
2. Knowledge about Environment and population growth, knowledge about the solution and prevention of environmental problems, rational use of resources.
3. Environmental education- goals, objectives, guided principles.
4. Strategies for environmental education- Authorisation, Curriculum renewal, teacher's training renewal, teaching methods, evaluation.
5. Models for future environmental education system.

**UNIT-II**

**Environmental institutions and international cooperation:**

1. Environmental Institutions, International Union for Conservation of Nature and Natural Resources (IUCN), World Wildlife Fund (WWF), US Environmental Protection Agency (EPA).
2. Global Environmental Agreements, Institutions of climate change, Indian Environmental Institutions, Central Pollution Control Board (CPCB).
3. Environmental Policies in India, Environmental Laws/Acts, National Environmental Tribunal Bill, 1992.
4. Environmental movements in India- The Chipko movement, Silent Valley movement, Appiko movement, Narmada Bachao Andolan, Teri Dam Conflict.

**UNIT-III**

**Environmental laws:**

1. Environmental Legislation status in India.
2. The Water (Prevention and Control of Pollution) Act, 1974.
3. The Air (Prevention and Control of Pollution) Act, 1981.
4. The Environment (Protection) Act, 1986.
5. The Biological Diversity Act, 2002.
6. The Wildlife (Protection) Act, 1972.
7. Bio-Medical Waste (Management and Handling) Rules, 1998.

**UNIT-IV**

**National and international regulatory organizations:**

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(in charge)  
University of Jammu  
JAMMU  
2018

1. MoEF (Ministry of Environment And Forests), ZSI (Zoology Survey of India) WII (Wild life Institute of India), Bombay Natural History Society (BNHS).
2. Zoo Authority of India (ZAI), Salim Ali Centre for Ornithology & Natural History (SACONH), Indira Gandhi Conservation and Monitoring Centre (IGCMC), National Biodiversity Authority (NBA), Animal Welfare Board of India (AWBI), Centre for Environment Education (CEE).
3. WWF (World Wildlife Fund), UNEP (United Nations Environment Programme), CITES (Convention on International Trade of Endangered Species).
4. World Heritage and Biodiversity Convention, UNESCO (United Nations Educational, Scientific and Cultural Organization).
5. Ramsar (Wetland) sites in India and Ramsar convention.

### Practicals

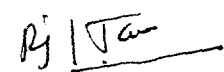
1. Measurement of particulate air pollutants, dust fall and suspended particulate matter from different sites.
2. Measurement of Noise pollution of different areas.
3. Water Quality Analysis: Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate, Silica and fluoride.
4. Determination of total suspended and dissolved solids/salts (TSS & TDS).
5. Toxicity Analysis of Water: For Chlorine, H<sub>2</sub>S, Ammonia, Copper and Chromium.
6. Estimation of BOD and COD of polluted water.
7. Determination of LC<sub>50</sub> for fish (pesticide) using Probit analysis (use of appropriate software is suggested).
8. Study of Histo-pathological changes in any two of the tissues (Liver/ Kidney/ Gonad) using pesticide/heavy metal/nanoparticle.
9. Isolation and Enumeration of microorganisms in soil, water and air.
10. Bacteriological quality testing of water and wastewater: (a). Presumptive coliform test (MPN Index), (b). Confirmatory coliform test, Completed test.
11. Boric acid test for turmeric in chilly and coriander powder.
12. Detection of Lead chromate in chilly, and turmeric powder.
13. Detection of Colophony resin in Asafoetida.
14. Detection of cane sugar in milk.
15. Detection of starch and cellulose in milk.
16. Detection of added Glucose in milk and milk powder.
17. Foreign vegetable fats in milk.
18. Standard Plate Count in milk.
19. Study of water borne diseases.
20. Case studies on oil pollution and nuclear reactor disasters (At least one each).
21. Project work: To locate and describe water harvesting system like tanka/bavri in and around Jaipur and physicochemical and microbiological analysis of their water. (This can be done as part of the three / four day field study compulsory for this elective).
22. Visit to Institutions engaged in environmental management/Toxicology research and an industrial /polluted area. Report the study conducted and submit a write up/ print out giving the dates, methodology, results and references. Include photographs of the activity.

### Recommended Books

1. Environmental Microbiology: Maier, R.M, Pepper, I. L., Gerba, C. P.
2. The Basic Science of poisons. Casarett & Doull's Toxicology: Curthis Klassen.
3. Biotechnology: Applying the Genetic Revolution, Clark, D. P. & Tazdernik, N. J..
4. Principle of Environmental Science, Cunningham, W.P. & Cunningham, M...
5. Microbiology Fundamentals and Application, Purohit, S. S.
6. Microbial Biopesticides, Koul, O & Dhaliwal, G. S.
7. Bioremediation Technology, Fulekar, M. H.
8. Biotransformation: Bioremediation Technology for Health & Environmental Protection, Stapleton Jr., R. D. & Singh, V. P. Elsevier.
9. Methods of analysis for Adulterants and Contaminants in foods. Toteja, G.S., Mukherjee, A., Mittal, R., Saxena, B. N. Indian Council of Medical Research, New Delhi.
10. Environmental pollution-Health and Toxicology. Rana, S. V. S. Narosa Publishing House, New Delhi.
11. Fundamentals of Toxicology. Pandey, K., Shukla, J. P., Trivedi, S. P. New Central Book-Agency (P) Ltd. Kolkata.
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13. Principles of Ecotoxicology. Butter, G.C.1988. John Wiley and Sons.
14. Basic Environmental Toxicology. Cockerham, G.L. and Shane, B.S. 1994. (Eds.). CRC Press.
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16. Chemistry of Pollution. Fellenberg, G. 1999. John Wiley and Sons, New Delhi.
17. Principles and Methods of Toxicology. Hayes, W.A. 2001. CRC Press, NY.
18. Methods of Air sampling and Analysis (3rd Edn.). James, P. Lodge, J.R, .ISc Lewis Pub., INC.
19. Essentials of Toxicology. Klaassen, C.D and J.B.Walkins. 2003. Mc Graw -Hill Professional New Delhi.
20. Toxicology- Principles and Applications. Niesink, R.J.M., De Vries, J. and Hollinger, M.A. 1996. (Eds.). CRC Press.
21. Toxicity of Heavy Metals in Environment. Oehme, W.F. 1989. Marcel Dakkar Inc., New York.
22. Waste Water Engineering Including Air Pollution. Purnima, B.B., A.K. Janin and Arun K. Jain. 2011. Laxmi Publications (P) Ltd. New Delhi.
23. Biological aspects of Water Pollution. Wilber, C.G.1989. Charles C. Thomas Publishers, Illinois, USA.
24. EIA for Developing Countries. Asit K. Biswas et al., 1987, United Nations University, Tokyo.
25. Environmental Impact Assessment. Carter, L.1996. McGraw Hill, New Delhi.
26. Microbial Ecology: Fundamentals and Applications. Ronald M. Atlas, Richard Bartha. Benjamin/Cummings.

ZOL 412D: PRACTICAL-VIII

Scheme for Practical Examination  
(Based on ZOL 4D01, ZOL 4D02 and ZOL 4D03)

  
Dy. Registrar  
(Academic)  
University of Rajasthan  
JAIPUR

Max Marks: 100

Time: 6 hrs

1. Exercise	16
2. Exercise	16
3. Exercise	16
4. Spotting (8 × 3)	24
5. Seminar	09
6. Viva Voce	10
7. Record	09

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife act 1972 and amendments made subsequently.

**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP E (SPECIAL PAPER)  
ZOL 4E01: REPRODUCTIVE BIOLOGY  
PHYSIOLOGY OF REPRODUCTION**

Max. Marks: 100

Total Hours: 60

**UNIT-I**

**Fertilization:**

1. Prefertilization events.
2. Biochemistry of fertilization
3. Post-fertilization events
4. Capacitation.

**UNIT-II**

**Implantation:**

1. Implantation, decidual changes
2. Hormonal regulation.
3. Delayed implantation

**Placenta as endocrine tissue: foeto-placental unit.**

**UNIT-III**

**Gestation:**

1. Physiological changes
2. Pregnancy tests
3. Hormonal regulation.

**Parturition:**

1. Onset of parturition
2. Hormonal control of parturition.

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(Academic)  
University of Rajasthan  
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**Lactation:**

1. The mammary gland
2. Hormonal control of lactation.

**UNIT-IV**

**Miscellaneous factors affecting reproduction:**

1. Nutrition and reproduction
2. Effect of light, temperature
3. Environmental disruptors
4. Change of lifestyle.

**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP E (SPECIAL PAPER)  
ZOL 4 E02: REPRODUCTIVE BIOLOGY  
CONTRACEPTION AND REPRODUCTIVE HEALTH**

**Max. Marks: 100**

**Total Hours: 60**

**UNIT-I**

**Fundamental aspects of control of fertility in males:**

1. Mechanical
2. Surgical
3. Chemical
4. Immunological methods.

**UNIT-II**

**Fundamental aspects of control of fertility in females:**

1. Natural.
2. Mechanical.
3. Surgical.
4. Chemical.
5. Immunological.
6. Emergency contraception.

**UNIT-III**

**Sexually transmitted diseases: Pathophysiology, diagnosis, mprevention, treatment of**

1. Bacterial diseases (Syphilis. Gonorrhea)
2. Viral (AIDS)
3. Fungal (Candidiasis)
4. Protozoan (Trichomoniasis)

**Hormones and cancer:**

1. Definition of cancer
2. Benign and malignant tumor

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Dy. Registrar  
*(Signature)*

3. Types of cancer: Prostate, cervical, breast, testicular and ovarian cancers
4. Cancer problem in India
5. Hormones and cancer

#### UNIT-IV

Teratological effects of Xenobiotics.

#### Demography:

1. Population growth rate
2. National population policy
3. Pearl Index
4. Family welfare programmes

**M.Sc. ZOOLOGY IV SEMESTER  
ELECTIVE GROUP E (SPECIAL PAPER)  
ZOL 4 E03: REPRODUCTIVE BIOLOGY  
REPRODUCTIVE TECHNOLOGIES**

Max. Marks: 100

Total Hours: 60

#### UNIT-I

#### Reproductive dysfunctions in males and females:

1. Endocrinological
2. Physiological
3. Anatomical
4. Congenital
5. Idiopathic factors

#### Diagnosis of male infertility:

1. Semen analysis: Physical examinations, microscopic examinations, biochemical analysis, Immunological tests.
2. Sperm functional tests: Zona binding assays, hamster-oocyte penetration test, Hypo-osmotic swelling test, acrosome reaction, Acrosome intactness test, Nuclear chromatin decondensation test, Sperm mitochondrial activity index test.
3. Endocrinological diagnosis.

#### UNIT-II

#### Diagnosis of female infertility:

1. Monitoring of ovarian and reproductive cycles.
2. Endometrial biopsy.
3. Ductal blockage.
4. Endocrine diagnosis

#### Assisted reproductive technology (ART):

1. Artificial insemination
2. Super ovulation, oocyte collection.

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3. Collection and preparation of sperm for assisted fertilization.
4. In vitro fertilization and related techniques (IVF, GIFT, ZIFT, TET, ICSI etc.).
5. Ethical issues and regulatory guidelines

**Cryopreservation:**

1. Semen,
2. Oocytes
3. Embryos

**UNIT-III**

1. Animal cloning.
2. Sperm and embryo sexing.
3. **Animal husbandry:**
  - a. Improvement of breeds of farm animals
  - b. Artificial insemination and embryo transfer technique
  - c. Transgenic animals.
  - d. Induction of early puberty in cattle

**UNIT-IV**

1. Pre-natal diagnosis of genetic diseases.
2. **Hormonal bioassay:** Principles, Procedure and applications
  - a. ELISA
  - b. Radio immunoassay (RIA)
  - c. Radioreceptor binding assay
  - d. Immuno-cytochemistry.

**Practicals**

1. Surgical procedure in reproduction:
  - (i) Castration
  - (ii) Ovariectomy
  - (iii) Adrenalectomy
  - (iv) Vasectomy
2. Biochemical investigation of marker parameters.
3. Induction of superovulation and collection of oocytes.
4. Hormonal bioassays estrogens & androgen.
5. Pregnancy test.
6. Biochemical investigations of the reproductive glands with special reference to their markers. Fructose, glycogen, cholesterol, Acid & Alkaline phosphatase.
7. Electrophoresis: Study of protein profile in epididymic fluid.
8. Demonstration of *in vitro* fertilization (GIFT, ZIFT, TET, ICSI, etc.).
9. Immunoassays: RIA, ELISA.
10. Monitoring of sperm function tests.
11. Visit to State and National laboratories /Institute

**Note:** it should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.



### Recommended Books

1. Reproduction in Domestic animals. Cole, H. H. and Cupps P. T. Academic Press, New York.
2. Male Fertility and Infertility, Clover TD. and Barratt C.L.R. Cambridge University Press, Cambridge, 1999.
3. Biology of Human Reproduction. Pinon, Jr. R. University Science Books California, 2002.
4. The Reproductive Physiology of Mammals: From Farm To Field And Beyond, Keith K. Schillo Cengage Delmar Learning 2008.
5. Assisted Reproductive Technology: A Reference Book on A.R.T., Philippe Merveil Eska Publishing, 2010.
6. Reproductive Endocrinology & Infertility, Daftary & Patki BI Publications Pvt Ltd, 2009.
7. Reproductive Endocrinology and Infertility: Integrating Modern Clinical and Laboratory Practice, Douglas T. Carrell Springer, 2010.
8. Andrology: Male Reproductive Health and Dysfunction, Eberhard Nieschlag, Hermann M. Behre, Susan Nieschlag Springer, 2010.
9. Reproductive Endocrinology: A Molecular Approach, Pedro J. Chedres Springer, USA, 2009.
10. Hormonal Contraception: Birth Control, Endocrine System, Steroid Hormone, Frederic P. Miller, Agnes F. Vandome, John McBrewster Alpha Script Publishing, 2010.
11. Hormonal contraception, Ronald T. Burkman, Steven G. Gabbe Wolter Kluwer ; Lippincott Williams & Wilkins, 2007.
12. Text Book on Sexually Transmitted Diseases and AIDS by IASSTD & AIDS, Vinod K Sharma, Rishi Bhargava and N. Usman VIVA BOOKS PVT. LTD, Jaipur
13. Sexually transmitted diseases: epidemiology, pathology, diagnosis, and treatment By Kenneth A. Borchardt, Michael A. Noble CRC Press, 1997.
14. Sexually transmitted diseases, Louise I. Gerdes Greenhaven Press, 2002.
15. Reproductive Biotechnology of Farm Animals, Dugwekar Vg Agrotech Publishing Academy, 2006.
16. Biotechnology of human reproduction, Alberto Revelli, Ilan Tur-Kaspa, Jan Gunnar Holte Parthenon Pub. Group, 2003.
17. Menopause: Biology and Pathobiology, Lobo, Rogerio A. Academic Press 2000.
18. Dynamics of human reproduction: biology, biometry, demography, James W. Wood Transaction publishers 1994.
19. Introduction To Endocrinology, Negi PHI Learning Pvt Limited, New Delhi, 2009.
20. The Reproductive System, Kara Rogers (Ed.) Britannica Educational Publishing, 2010.
21. WHO. Laboratory manual for the examination of human semen and sperm-cervical mucus interaction. Cambridge: Cambridge University Press; 1999 & 2010.

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**ZOL 412E: PRACTICAL-VIII**

**Scheme for Practical Examination**  
(Based on ZOL 4E01, ZOL 4E02 and 4E03)

**Max. Marks: 100**

**Time: 6 hrs**

1. Exercise	16
2. Exercise	16
3. Exercise	16
4. Spotting (8 × 3)	24
5. Seminar	09
6. Viva Voce	10
7. Record	09

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